

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Examiner: Daniel Lawson Greene

Group Art Unit: 3694

In re Application of:  
Kirkland D. Broach et al.

Serial No. 10/751,349

Filed: January 5, 2004

NUCLEAR FUEL ASSEMBLY DEBRIS  
FILTER BOTTOM NOZZLE

Attorney Docket No. ARF-2004-003

**APPELLANTS' BRIEF ON APPEAL**

March 19, 2007

Commissioner for Patents  
MAIL STOP APPEAL BRIEF - PATENTS  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

This is an Appeal from the decision of the Examiner, dated July 18, 2006, rejecting Claims 1, 2 and 4-17 of the above-identified application. The claims are set forth in the Claims Appendix, which is attached hereto. Due to the specific nature of the issues involved in this Appeal, an Oral Hearing is not deemed necessary and is not requested. Payment of the filing fee for Appellants' Brief in the amount of \$500.00 will be charged to Eckert Seamans Cherin & Mellott, LLC's American Express Card during the electronic submission process. Please charge any deficiency in payment or credit any overpayment to Deposit Account No. 02-2556.

**Real Party In Interest**

The real party in interest is Westinghouse Electric Company LLC, seventy-seven percent owned by Toshiba Corporation, twenty percent owned by the Shaw Group, Inc. and three percent owned by Ishikawajima Harima Industries Company, LTD. An assignment from the inventors to Westinghouse Electric Company LLC was recorded on January 5, 2004, and is recorded at Reel/Frame 014875/0020.

### **Related Appeals and Interferences**

There are no appeals or interferences known to Appellants or to Appellants' legal representative which will directly affect, be directly affected by, or have a bearing on the Board's decision in the pending appeal.

### **Status of the Claims**

Claims 1, 2 and 4-17 are rejected and are on appeal. Claim 3 has been canceled. Claims 4 and 7-11 stand or fall with Claim 1 and Claims 14 and 15 stand or fall with Claim 13. Claims 1, 2, 5, 6, 12, 13, 16 and 17 distinguish for the individual limitations that they introduce and stand or fall by themselves. More specifically the status of the claims are:

Claims 1, 2 and 4-17 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirements.

Claims 1, 2 and 4-17 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement.

Claims 1, 2 and 4-17 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

Claims 1, 2 and 7-12 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger (4,900,507) in view of any of U.S. Patents 4,997,621 to Johansson et al. ('621), U.S. Patent 5,528,640 to Johansson et al. ('640), U.S Patent 5,473,650 to Johansson ('650) or U.S. Patent 5,488,634 to Johansson et al. ('634).

Claims 4, 6 and 13-17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger as modified by any of U.S. Patents 4,997,621 to Johansson et al., U.S. Patent 5,528,640 to Johansson et al., U.S Patent 5,473,650 to Johansson or U.S. Patent 5,488,634 to Johansson et al. Further, in view of the teachings of the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958.

Claims 1, 2, 4 and 6-17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999 or the Industrial Burners' Handbook, CRC Press LLC, copyright 2003 or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958 and further in view of

either Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958, or Tucker (4,118,973).

Claim 5 is rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger and further in view of the teachings of Chapter 42, Fluid Measurements, of The Engineering Handbook, CRC Press LLC, copyright 2000.

#### **Status of the Amendments**

There are currently no outstanding amendments to the pending claims. The claims as they stand on Appeal are contained in the Claims Appendix to this Brief.

#### **Summary of the Claimed Subject Matter**

Independent Claim 1 calls for a pressurized water reactor fuel assembly 10 (page 4 line 18 et seq., Fig. 1) having a debris filter bottom nozzle 12 (page 6, line 2, Fig. 1). The debris filter bottom nozzle 12 comprises a substantially horizontal plate 46 (page 6, line 5, Fig. 1) extending substantially traverse to the axis of fuel rods 22 (page 5, line 3, Fig. 1), an upper face directed toward a lowermost spacer grid 20 (page 5, line 4, Fig. 1). The upper face of the plate 46 has defined therethrough at least two different hole designs 52 and 48 (page 8, line 6, Figs. 3 & 5). The holes 52 (page 7, line 23, Fig. 3) are designed to receive lower ends of guide thimbles 18, which are supported by the plate 46. The second hole design 48 (page 8, line 6, Figs. 3 & 5) is formed as flow through holes extending completely through the plate 46 for the passage of coolant fluid from a lower face of the plate 46 to the upper face of the plate 46 with each of the coolant flow through holes extending substantially in the axial direction of the fuel rods 22 and in fluid communication with unoccupied spaces in the spacer grids 20. The flow through holes 48 are said to have a profile substantially of a venturi (page 8, line 9, Fig. 5) with flaring at both ends. The flaring at the lower face of the plate 46 comprises a series of a plurality of concentric countersinks 56 (page 8, line 27, Fig. 5) of different included angles and depths (page 9, line 7, Fig. 5) into the coolant flow through hole.

Independent claim 12 calls for a debris filter bottom nozzle 12 (page 6, line 2, Fig. 1) for a pressurized water reactor fuel assembly 10. The debris filter bottom nozzle 12 comprises a substantially horizontal plate 46 (page 6, line 5, Fig. 1)

extending substantially traverse to the axis of fuel rods 22 (page 5, line 3, Fig. 1), an upper face directed toward a lowermost spacer grid 20 (page 5, line 4, Fig. 1). The upper face of the plate 46 has defined therethrough at least two different hole designs 52 and 48 (page 8, line 6, Figs. 3 & 5). The holes 52 (page 7, line 23, Fig.3) are designed to receive lower ends of guide thimbles 18, which are supported by the plate 46. The second hole design 48 (page 8, line 6, Figs. 3 & 5) is formed as flow though holes extending completely through the plate 46 for the passage of coolant fluid from a lower face of the plate 46 to the upper face of the plate 46 with each of the coolant flow through holes extending substantially in the axial direction of the fuel rods 22 and in fluid communication with unoccupied spaces in the spacer grids 20. The flow through holes 48 are said to have a profile substantially of a venturi (page 8, line 9, Fig. 5) with flaring at both ends. The flaring at the lower face of the plate 46 comprises a series of a plurality of concentric countersinks 56 (page 8, line 27, Fig. 5) of different included angles and depths (page 9, line 7, Fig. 5) into the coolant flow through hole.

Independent Claim 13 calls for a pressurized water reactor fuel assembly 10 (page 4 line 18 et seq., Fig. 1) having a debris filter bottom nozzle 12 (page 6, line 2, Fig. 1). The debris filter bottom nozzle 12 comprises a substantially horizontal plate 46 (page 6, line 5, Fig. 1) extending substantially traverse to the axis of fuel rods 22 (page 5, line 3, Fig. 1), an upper face directed toward a lowermost spacer grid 20 (page 5, line 4, Fig. 1). The upper face of the plate 46 has defined therethrough at least two different hole designs 52 and 48 (page 8, line 6, Figs. 3 & 5). The holes 52 (page 7, line 23, Fig.3) are designed to receive lower ends of guide thimbles 18, which are supported by the plate 46. The second hole design 48 (page 8, line 6, Figs. 3 & 5) is formed as flow though holes extending completely through the plate 46 for the passage of coolant fluid from a lower face of the plate 46 to the upper face of the plate 46 with each of the coolant flow through holes extending substantially in the axial direction of the fuel rods 22 and in fluid communication with unoccupied spaces in the spacer grids 20. The contour of the flow through holes 48 has a discrete, double chamfered inlet 56 (page 9, line 1, Fig. 5) with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer relative to

the axial direction of the fuel rods 22. The corresponding portion of the specification can be found starting at page 8, line 24 through page 10, line 10.

More specifically, the claims addressed on this appeal that distinguish for the individual limitations that they introduce are:

1. A fuel assembly 10 (page 4, line 17, Fig. 1) for a pressurized water nuclear reactor including a plurality of elongated nuclear fuel rods 22 (page 4, line 31, Fig. 1) having an extended axial length, at least a lowermost grid 20 (page 5, line 27, Fig. 1) supporting said fuel rods in an organized array and having unoccupied spaces (page 6, line 22, Fig. 1) defined therein adapted to allow flow of fluid coolant therethrough and past said fuel rods 22 when said fuel assembly 10 is installed in the nuclear reactor and a plurality of guide thimbles 18 (page 4, line 26, Fig. 1) extending along said fuel rods through and supporting said grid, a debris filter bottom nozzle 12 (page 5, line 25, Fig. 1) disposed below said grid, below lower ends of said fuel rods, supporting said guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate 46 (page 6, line 5, Fig. 3) extending substantially transverse to the axis of the fuel rods and having an upper face directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design 52 (page 7, line 23, Fig. 3) being a plurality of holes receiving lower ends of said guide thimbles where they are supported by said plate and the second hole design 54 (page 8, line 6, Fig. 5) being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and in the extended direction at least some of said coolant flow through holes having a profile substantially of a venturi with flaring at both ends, wherein the flaring 56 at the lower face of said plate (page 8, line 27, Fig. 5) comprises a series of a plurality of concentric countersinks of different included angles and depths (page 9, line 7, Fig. 5) into the coolant flow through hole.

2. The nuclear fuel assembly of Claim 1 wherein said coolant flow through holes having a profile substantially of a venturi have an inlet end in the lower face of said plate and an outlet end in the upper face of said plate wherein the venturi is

substantially formed by the concentric countersinks of different included angles and depths into the coolant flow through hole in said inlet and a chamfer in said outlet end.

5. The nuclear fuel assembly 10 of Claim 4 wherein the chamfers 56 (page 8, line 28, Fig. 5) have the following dimensions and angles relative to a flow axis of the flow through hole 54 (page 8, line 6, Fig. 5) where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and Chamfer C is at the outlet of the flow through holes (page 9, line 7, Fig. 5).

	Angle	Nominal Length (in.)	Maximum Length (in.)	Minimum Length (in.)
Chamfer A	$35^\circ \pm 3^\circ$	0.017 (0.043 cm)	0.039 (0.099 cm)	0.012 (0.030 cm)
Chamfer B	$15^\circ \pm 3^\circ$	0.039 (0.099 cm)	0.057 (0.145 cm)	0.010 (0.025 cm)
Chamfer C	$10^\circ \pm 3^\circ$	0.085 (0.361 cm)	0.142 (0.361 cm)	0.059 (1.397 cm)

6. The nuclear fuel assembly 10 of Claim 4 wherein the chamfers 56,58 (page 9, line 14, Fig. 5) have the following relative dimensions and angles with regard to a flow axis of the flow through hole where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and Chamfer C is at the outlet of the flow through holes and L/T is the length of the chamfer divided by the thickness of the plate 46.

Angle	Chamfer L/T		
	Maximum	Minimum	
Chamfer A	2.33 x B	0.071	0.020
Chamfer B	$15^\circ \pm 3^\circ$	0.104	0.017
Chamfer C	0.67 x B	0.258	0.101

12. A debris filter bottom nozzle (page 6, line 2, Fig.1) for a pressurized water nuclear reactor fuel assembly 10 having a plurality of elongated nuclear fuel rods having an extended axial length, at least a lowermost grid supporting said fuel rods 22 (page 4, line 31, Fig. 1) in an organized array and having unoccupied spaces defined

therein (page 6, line 22, Fig. 1) adapted to allow flow of fluid coolant therethrough and past said fuel rods 22 when said fuel assembly 10 is installed in the nuclear reactor, a plurality of guide thimbles 18 (page 4, line 26, Fig. 1) extending along said fuel rods through and supporting said grid, said debris filter bottom nozzle 12 (page 5, line 25, Fig. 1) designed to be disposed below said grid, below lower ends of said fuel rods, to support said guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate 46 (page 6, line 5, Fig. 3) extending substantially transverse to the axis of the fuel rods and having an upper face to be directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design 52 (page 7, line 23, Fig. 3) being a plurality of holes for receiving lower ends of said guide thimbles where they are to be supported by said plate and the second hole design 54 (page 8, line 6, Fig. 5) being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes when incorporated in said fuel assembly, extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and in the extended direction at least some of said coolant flow through holes having a profile substantially of a venturi with flaring at both ends, wherein the flaring 56 at the lower face of said plate (page 8, line 27, Fig. 5) comprises a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle (page 9, line 7, Fig 5) than another adjacent chamfer relative to the axial direction of said fuel rods.

13. A fuel assembly 10 (page 4, line 17, Fig. 1) for a pressurized water nuclear reactor including a plurality of elongated nuclear fuel rods 22 (page 4, line 31, Fig. 1) having an extended axial length, at least a lowermost grid 20 (page 5, line 27, Fig. 1) supporting said fuel rods in an organized array and having unoccupied spaces (page 6, line 22, Fig. 1) defined therein adapted to allow flow of fluid coolant therethrough and past said fuel rods when said fuel assembly 10 is installed in the nuclear reactor, a plurality of guide thimbles 18 (page 4, line 26, Fig. 1) extending along said fuel rods through and supporting said grid, a debris filter bottom nozzle 12 (page 5, line 25, Fig. 1) disposed below said grid, below lower ends of said fuel rods, supporting said

guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate 46 (page 6, line 5, Fig. 3) extending substantially transverse to the axis of the fuel rods and having an upper face directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design 52 (page 7, line 23, Fig. 3) being a plurality of holes receiving lower ends of said guide thimbles where they are supported by said plate, the second hole design 54 (page 8, line 6, Fig. 5) being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and at least some of said coolant flow through holes having a discrete, double chamfered inlet 56 (page 8, line 27, Fig. 5) with each adjacent chamfer of the double chamfered inlet at a different angle (page 9, line 7, Fig. 5) than the other adjacent chamfer relative to the axial direction of said fuel rods.

16. The nuclear fuel assembly 10 of Claim 13 wherein the chamfers 56 (page 8, line 28, Fig. 5) have the following dimensions and angles relative to a flow axis of the flow through hole 54 (page 8, line 6, Fig. 5) where Chamfer A is the chamfer closest to an inlet of the flow through hole and Chamfer B is the chamfer adjacent Chamfer A, spaced from the inlet (page 9, line 7, Fig. 5).

	Angle	Nominal Length (in.)	Maximum Length (in.)	Minimum Length (in.)
Chamfer A	$35^\circ \pm 3^\circ$	0.017 (0.043 cm)	0.039 (0.099 cm)	0.012 (0.030 cm)
Chamfer B	$15^\circ \pm 3^\circ$	0.039 (0.099 cm)	0.057 (0.145 cm)	0.010 (0.025 cm)

17. The nuclear fuel assembly 10 of Claim 13 wherein the chamfers 56 (page 9, line 11, Fig. 5) have the following relative dimensions and angles with regard to a flow axis of the flow through hole where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and L/T is the length of the chamfer divided by the thickness of the plate.

	Angle	Chamfer L/T	
		Maximum	Minimum
Chamfer A	2.33 x B	0.071	0.020
Chamfer B	15° +/- 3°	0.104	0.017

### **Grounds of Rejection to be Reviewed on Appeal**

#### **I. Rejections Under 35 U.S.C. §112**

- A. Whether Claims 1, 2 and 4-17 comply with the written description requirements.
- B. Whether Claims 1, 2 and 4-17 comply with the enablement requirement.
- C. Whether Claims 1, 2 and 4-17 are indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

#### **II. Claim Rejections Under 35 U.S.C. §103**

A. Whether Claims 1, 2 and 7-12 are obvious over Shallenberger (4,900,507) in view of any of U.S. Patents 4,997,621 to Johansson et al. ('621), U.S. Patent 5,528,640 to Johansson et al. ('640), U.S Patent 5,473,650 to Johansson ('650) or U.S. Patent 5,488,634 to Johansson et al. ('634).

B. Whether Claims 4, 6 and 13-17 are obvious over Shallenberger as modified by any of U.S. Patents 4,997,621 to Johansson et al., U.S. Patent 5,528,640 to Johansson et al., U.S Patent 5,473,650 to Johansson or U.S. Patent 5,488,634 to Johansson et al. as applied to Claims 1, 2 and 7-12 above, further, in view of the teachings of the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958.

C. Whether Claims 1, 2, 4 and 6-17 are obvious over Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999 or The Industrial Burners' Handbook, CRC Press LLC, copyright 2003 or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc.,

copyright 1958 and further in view of either Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958, or Tucker (4,118,973).

D. Whether Claim 5 is obvious over Shallenberger as applied to Claims 1, 2, 4 and 6-17 above and further in view of the teachings of Chapter 42, Fluid Measurements, of The Engineering Handbook, CRC Press LLC, copyright 2000.

### **Argument**

#### **I. Rejections Under 35 U.S.C. §112**

Authority in support of Applicants' position:

In support of Applicants' position, set forth below, with regard to the objections raised by the Examiner under 35 U.S.C. §112, the district court stated in *Advanced Cardiovascular Systems v. Scimed Life Systems*, 96 F.Supp.2d 1006, N.D.Calif. (decided 4/25/00) that:

A patent claim is sufficiently definite if those skilled in the art would understand what is claimed when the claim is read in light of the specification . . . mathematical precision should not be imposed for its own sake; a patentee has the right to claim the invention in terms that would be understood by persons of skill in the field of the invention.

Additionally, the Court of Appeals for the Federal Circuit in *Dental Prodx LLC v. Advantage Dental Products, Inc.*, 309 F.3d 774, 64 USPQ2d 1945 (10/25/02) held that:

Failure of a specification to specifically mention a limitation that later appears in the claims is not fatal if a person skilled in the art would recognize, upon reading the specification, that the new language reflects what the specification shows has been invented.

Furthermore, with regard to the limitation of a pressurized water reactor within the preamble of the claim, the Federal Circuit has held that a patent claim preamble limits claim scope if it recites essential structure that is important to the invention or necessary to give meaning to the claim. *Bicon, Inc. v. Straumann*, 441 F.3d 945, 78 USPQ 1267 (C.A.F.C. 3/20/06).

The objections raised under §112 and Applicants' position:

A. Claims 1, 2 and 4-17; Rejected Under 35 U.S.C. §112, First Paragraph  
– Written Description Requirement

Claims 1, 2 and 4-17 were rejected as failing to comply with the written description requirement. The Examiner asserted that the claims contained subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. In this regard, the Examiner asserted that the limitation “ . . . concentric countersinks of different included angles and depths into the coolant flow through hole” in Claims 1 and 2 is considered new matter since it is not seen where the specification uses such a phrase in the application as filed.

On page 8 of the specification starting on line 24, the specification states:

The venturi flow through hole design 54 of the debris filter bottom nozzle 12 was enhanced, from a manufacturing point of view, by optimizing the coolant flow paths through the nozzle flow plate 46. The straight bore flow holes, with single inlet chamfering that was described in the ‘507 patent [Shallenberger U.S. Patent 4,900,507], was replaced with double inlet chamfers 56 and a single outlet chamfer 58 to form the venturi 54 shown in Figure 5. The angles of the chamfers were optimized to provide the lowest pressure drop. In effect, they approximate a curved surface and streamline the flow through the holes 48. Controlling and inspecting the current geometry is difficult and expensive. The inventors have found, through computational fluid dynamics and experimentation, that as little as two straight chamfers, if configured properly, could develop flow similar to the curved geometry and result in a similar reduced pressure drop, with less cost.

The specific angles and lengths of the chamfers are then set forth in the two tables appearing on page 9 of the specification and fully define the chamfers illustrated in Figure 5. Thus, the specification clearly states that as little as two straight chamfers could develop flow similar to the curved geometry of a normal

venturi, with less cost. Though the preferred embodiment employs two inlet chamfers, that does not preclude the use of three chamfers, with the concomitant additional manufacturing costs, provided that they are each straight rather than curved to avoid the additional expense of controlling a curved surface in the manufacturing process.

In a response dated August 30, 2005, an amended Claim 1 described the flow through holes as having a profile substantially of a venturi with flaring at both ends, wherein the flaring at the lower face of said plate comprises a series of a plurality of discrete chamfers with adjacent chamfers at different angles to the axial direction of the fuel rods. That profile is specifically shown in Figure 5 and described on pages 8 and 9 of the specification, as mentioned above. Nevertheless, the Examiner objected to this language in the Office Action mailed November 16, 2005. In response, Applicants amended Claim 1 in an attempt to cure the Examiner's objections by describing the same flow through profile employing different words to say the same thing. In Claim 1, the phrase "discrete chamfers with adjacent chamfers at different angles to the axial direction of the fuel rods" was changed to "concentric countersinks of different included angles and depths into the coolant flow through hole." Applicants admit that the specification does not use the same exact words as the latter phrase, but it describes the same thing in different terms. Accordingly, the same should not be considered new matter.

Independent Claims 12, in the response dated April 10, 2006, describes the flaring at the lower face of said plate as comprising "a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of the fuel rods."

Independent Claims 13, in the response dated April 10, 2006, also describes the flaring at the lower face of said plate as comprising “a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of the fuel rods.”

On page 11 of the Argument Section, Applicants stated that two different approaches were taken in Claims 1 and 12 to describe the flow through hole profile. Applicants considered either the approach of Claim 1 or that of Claim 12 to be equivalent in describing the invention. Applicants indicated that they were willing to conform the claims to either approach if the Examiner found either approach acceptable. However, obviously the Examiner did not find either approach acceptable, which is in part the reason for this appeal.

Under Section 112, the Examiner also objected to the phrase “ . . . wherein the flaring at the lower face of said plate comprises a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods.” The Examiner considered the terms “straight”, “adjacent”, “each”, and “than another adjacent chamfer relative to” as new matter. For the reasons stated above, Applicants assert that these terms are not new matter, but are fully supported by the description provided on pages 8 and 9 of the specification and Figure 5.

B. Claims 1, 2 and 4-17; rejected under 35 U.S.C. §112, First Paragraph – Enablement Requirement

Claims 1, 2 and 4-17 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement. In support of this rejection, the Examiner asserted that the limitation “ . . . concentric countersinks of different included angles and depths into the coolant flow through hole” had no adequate

description nor enabling disclosure in the specification. Similarly, the Examiner asserted that the limitation “wherein the flaring at the lower face of said plate comprises a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods” had no adequate description or enabling disclosure in the specification. The response to the preceding rejection under 35 U.S.C. §112 applies equally as well to this rejection in that pages 8 and 9 of the specification and Figure 5 fully describe the claimed contour of the flow through holes as claimed in Applicants’ Claims 1, 2 and 4-17.

Claim 1 describes the flaring of the flow through hole at the lower face of the lower nozzle plate as comprising a series of a plurality of concentric countersinks of different included angles and depths. On page 8 starting at line 24 the specification states:

The venturi flowthrough hole design 54 of the debris filter bottom nozzle 12 was enhanced, from a manufacturing point of view, by optimizing the coolant flow paths through the nozzle flow plate 46. The straight bore flow holes, with single inlet chamfering that was described in the ‘507 patent, was replaced with double inlet chamfers 56 and a single outlet chamfer 58 to form the venturi 54 shown in Figure 5. The angles of the chamfers were optimized to provide the lowest pressure drop.

The angle and depth of each chamfer are fully described in the tables on page 9 and the paragraphs immediately preceding the tables identify which chamfers the figures in the table apply to. Figure 5 specifically shows the double chamfer at the inlet. the description provided on pages 8 and 9 of the specifications and the illustration provided in Figure 5 should make it clear that described flaring forms at least two concentric countersinks of

different included angles and depths. Thus it is respectfully asserted that this objection is improper and should be withdrawn.

Claim 12 describes the flaring at the lower face of the plate as comprising a series of a plurality of straight, discrete, adjacent chamfers at a different angle than another adjacent chamfer relative to the axial direction of the fuel rods. Figure 5 clearly shows a series, i.e., one after the other, of plural, straight, discrete adjacent chamfers with the chamfers at different angles. The tables on page nine fully define the angles of the chamfers. Accordingly Applicants assert that the Claim 12 language is fully supported by the specification.

Claim 13 describes the flow through holes as having a discrete, double chamfered inlet with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer. As stated with regard to Claim 12 this characterization of the venturi inlet is completely supported by the description and tables on pages 8 and 9 of the specification and Figure 5. Accordingly this objection to Claim 13 should be similarly withdrawn.

The foregoing objections applied to the dependent claims 2 and 4-17 should similarly be withdrawn for the above reasons given for the claims from which they depend.

C. Claims 1, 2 and 4-17; rejected under 35 U.S.C. §112, second paragraph

Claims 1, 2 and 4-17 are objected to under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. In this regard, the Examiner asserted that Claims 1 and 12 are vague, indefinite and incomplete. The Examiner

believed it unclear what was encompassed by the limitation “a series” because the figures only show one or two chamfers. The Examiner asserted that the term “series” connotes a broader meaning than the two adjacent chamfers disclosed within the specification. Additionally, the Examiner asserted that “a series of a plurality of discrete chamfers does not connote any particular chamfers, per se; hence the metes and bounds of the claim are undefined.”

Webster’s New Collegiate Dictionary defines “series” as a number of things or events of the same class coming one after another in spatial or temporal succession. “Plurality” is defined as the state of being plural. “Plural” is defined as relating to or consisting of or containing more than one, or more than one kind or class. The phrase “a series of a plurality” means more than one of a kind placed one after the other. The fact that the figures show only two chamfers should be irrelevant. The figures are used to describe the preferred embodiment, *i.e.*, the preferred mode of practicing the invention, not necessarily the only mode.

Additionally, the Examiner asserted that the phrase “a plurality of discrete chamfers” does not connote any particular chamfers per se, and thus the metes and bounds of the claim are undefined. The word “discrete” is defined by Webster’s New Collegiate Dictionary as constituting a separate entity; individually distinct. The term “plurality” was previously defined. The result is more than one distinct chamfer, in this case separated by a change in angle as clearly defined by the angle values set forth on page 9 of the specification.

The Examiner further asserted under this objection that the phrase “concentric countersinks of different included angles and depths into the coolant flow through hole” was vague and incomplete. The Examiner also objected to the phrase “ . . . wherein the flaring at the lower face of said plate comprises a series of a plurality of

straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods.” The same objection was made to the phrase “a series of a plurality.” These latter objections are redundant with those set forth above and the response to the former objections presented above applies equally as well to these latter objections.

More particularly with regard to Claim 1 the Examiner is apparently objecting to the phrase “*a series of a plurality of concentric countersinks of different included angles and depths into the coolant flow through hole*” as being vague and incomplete. The phrase “a series of a plurality” was discussed above. The term concentric has the common meaning of having a common axis (Websters New Collegiate Dictionary). A countersink is defined by Websters Third New International Dictionary as “a funnel-shaped enlargement at the outer end of a drilled hole...” The phrase “of different included angles” means that the sidewalls of the countersinks are at different angles to their common axis. It is not clear how the foregoing description can be considered either vague or incomplete. Therefore it is respectfully requested that the objection be withdrawn.

More particularly with regard to Claim 12 the Examiner is apparently objecting to the phrase “*a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods*”. From the foregoing definitions it should be apparent that this language describes an inlet having more than one chamfered inlet section adjacent each other and at different angles to the axial direction of the fuel rods, which is exactly what is described on pages 8 and 9 of the specification and shown in Figure 5. Therefore it is not clear how this phrase can rightfully be

considered vague and incomplete. Accordingly, it is respectfully requested that this objection be similarly withdrawn.

More particularly with regard to Claim 13 the Examiner is apparently objecting to the phrase “*at least some of said coolant flow through holes having a discrete, double chamfered inlet with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer relative to the axial direction of said fuel rods*”. All three objected to phrases are describing the same feature in different terms, but fully reflect what is described on pages 8 and 9 of the specification and shown in Figure 5. Therefore this objection to Claim 13 is improper and should be similarly withdrawn.

The objections to the dependent claims 2, 4-11 and 14-17 are predicated on the objections to the corresponding independent claims and should similarly be withdrawn.

## **II. Claim Rejections Under 35 U.S.C. §103**

### Authority in support of Applicants position set forth below:

The three-pronged test required for finding a *prima facie* case of obviousness under 35 U.S.C. §103(a) is:

- a) First, there must be some suggestion or motivation, either in the references themselves, or the knowledge of one skilled in the art, to modify the references or to combine reference teaching;
- b) Second, there must be a reasonable expectation of success; and finally,
- c) The prior art references must teach or suggest all the claimed limitations.

Each of these three prongs must be found in the prior art and not based on Applicant's disclosure. *In Re: Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991); M.P.E.P.2142.

The initial burden is on the Examiner to provide some suggestion of the desirability of doing what the inventor has done. "To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the Examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex Parte Clapp*, 227 USPQ 972, 973 (Board of Appeals and Interferences 1985); M.P.E.P.2142. In the foregoing arguments, Applicants have shown where the Examiner has not carried that burden.

The Court of Appeals for the Federal Circuit in *In Re Bell*, 991 F.2d 781, 26 USPQ2d 1529 (C.A.F.C. 4/20/93) stated:

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination.

The Court of Appeals for the Federal Circuit further stated in *In Re Fritch*, 972 F.2d 1260, 23 USPQ2d 1780 (C.A.F.C. 8/11/92) that:

The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification . . . here, the Examiner relied upon hindsight to arrive at the determination of obvious. It is impermissible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This Court has stated that "[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.

Evidentiary Support for Applicants Position:

In support of the non-obviousness of Applicants' claims Applicants offered two Declarations under 37 CFR 1.132 of Michael Y. Young , which are attached hereto in the Evidence Appendix. In paragraph 1 of the Office Action, the Examiner reaffirms his position of not giving any patentable weight to the original and supplemental 132 declarations of Michael Y. Young as being opinionated declarations. In the original declaration, Mr. Young set forth his credentials as an expert in fuel assembly manufacture. In a supplemental declaration dated April 6, 2006, Mr. Young specifically stated in paragraph 7 that Westinghouse's test results have shown that the double chamfered inlet of the instant invention has been found not to adversely impact the benefit of the venturi profile in the bottom nozzle coolant flow holes, but provides a significant manufacturing savings over the normal venturi gradient profile between the inlet and outlet of the venturi flow holes. In refusing to give patentable weight to Mr. Young's statements, the Examiner is substituting his opinion for the opinion of an expert.

In the Board of Appeals and Interferences decision in *Ex Parte Bruce A. Green and Gary W. Zlotnick* (Appeal No. 94-161A), the Board stated, "The Examiner's opinion to the contrary is just that, opinion, which the Examiner erroneously substitutes for that of an expert in the art" citing *In Re Zeidler*, 682 F.2d 961, 967, 215 USPQ 490, 494 (C.C.P.A. 1982). Furthermore, Section 7 of Mr. Young's supplemental declaration, as well as many of the other sections of the declaration, are not merely statements of opinion, but are sworn statements of fact.

The rejections under 35 U.S.C. §103 and Applicants' response:

A. Claims 1, 2 and 7-12 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger (4,900,507) in view of any of U.S. Patents 4,997,621 to Johansson et al. ('621), U.S. Patent 5,528,640 to Johansson et al. ('640), U.S.

Patent 5,473,650 to Johansson ('650) or U.S. Patent 5,488,634 to Johansson et al.

('634).

1. Claim 1. As noted in the specification, Claim 1 is an improvement over the Shallenberger design. The improvement comprising wherein at least some of said coolant flow through holes 54 having a profile substantially of a venturi with flaring at both ends, wherein the flaring 56 at the lower face of said plate 46 comprises a series of a plurality of concentric countersinks 56 of different included angles and depths into the coolant flow through hole 54. Shallenberger, as shown by reference character 50 in Figure 7 and the corresponding description in Column 6 starting at Line 56 provides a single inlet chamfer or countersink with no outlet chamfer.

Each of the Johansson et al. references are directed to a boiling water reactor fuel assembly while Applicants' and Shallenberger's inventions are directed to a pressurized water reactor fuel assembly. While the Examiner has not given any patentable weight to the recitation of a pressurized water reactor in the preamble, it should be appreciated that such a recitation modifies each of the elements of the fuel assembly, such as the support grids and control rods, which take on an entirely different form for a pressurized water reactor fuel assembly than they would for a boiling water reactor fuel assembly. The hydrodynamics for the two are completely different because the boiling water reactor fuel assembly is a canned fuel assembly with no cross-flow between assemblies within the core. In contrast, a pressurized water reactor fuel assembly has an open lattice with mixing vanes that promote a cross-flow of coolant among fuel assemblies within the core. Accordingly, the pressure drop experienced in both assemblies is completely different.

It should be appreciated that in a boiling water reactor fuel assembly, the lower nozzle is referred to as the lower tie plate. In the ‘621 patent, starting at Line 3 in Column 7, the reference states:

The increased pressure drop through the tie plate causes a more uniform distribution of flow. Referring to Figure 4, the jet coming from the nose piece encounters a higher resistance at the tie plate, which causes the jet to spread to the outer edges of the tie plate. It has been found by experimentation that the high pressure drop lower tie plate disclosed here causes nearly uniform flow across the entire bottom of the fuel bundle. Thus, it will be understood that in addition to providing a greater pressure drop on the passage of the coolant 50 through the lower tie plate L, the disclosed invention utilizes the energy of the pressure drop to produce a more uniform and even flow immediately adjacent the lower tie plate.

Uniform distribution of the flow in a boiling water reactor fuel assembly is particularly important because the fuel assembly is confined at its periphery by the can. Accordingly, there is little, if any, cross-flow among fuel assemblies. This is in contrast to a pressurized water reactor assembly where cross-flow throughout the assembly and the core is promoted by mixing vanes and open sides between grids. The preferred embodiment of the ‘621 patent employs a rounded inlet to the flow through holes through the tie plate. In Column 7 starting at Line 24, referring to Figure 5E, the reference describes an alternate embodiment in which:

The entrance to the lower aperture has a small chamfer 95 instead of a large radius. The small chamfer will cause a greater pressure drop. However, the increase in pressure drop is highly sensitive to the amount of chamfer. Therefore, it is more difficult to obtain a controlled pressure drop than in the preferred embodiment [rounded inlet].

Thus, the objective of the ‘631 patent in providing a controlled increase in pressure drop to obtain uniform flow is contrary to Applicants’ objective of reducing the pressure drop and thus the reference teaches away from Applicants’ invention. There is no teaching in the reference of flaring at both ends, nor is there any teaching of the flaring at the lower face of the nozzle plate that comprises a series of a plurality of

concentric countersinks of different included angles and depths into the coolant flow through hole. Furthermore, stated another way, there is no teaching in the reference to the coolant flow holes having a discrete, double chamfered inlet with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer relative to the axial direction of said fuel rods.

The '640 patent describes a debris catcher bottom nozzle for a boiling water reactor that is formed by a pair of superposed plates having a plurality of holes of substantially the same size, shape and pitch but wherein the holes of one of the pair of plates are offset from the holes of the other of the pair of plates by 1/2 the hole pitch. While discussing the holes in the plates, the reference states in Column 6 starting at Line 66 that:

Each hole 44 is essentially square in shape, with rounded corners 56. The holes are arranged in parallel rows in each of two perpendicular directions and are interconnected by a plurality of webs of ligaments 58 of uniform shape and thickness. As best seen in Figure 6, the webs or ligaments 58 have rounded upper and lower edges 60, 62, respectively, for minimization of flow resistance.

Figure 13 best shows the offset between the upper and lower flow channels that are defined by the webs 58 and 80 with a Gap there between. As explained in Column 7 starting at Line 45, the Gap controls the extent of pressure drop. As with the '621 reference, the '640 reference recognizes the need in a BWR to maintain the pressure drop where it states in Column 2 starting at Line 55 that:

Finally, through the fuel bundle itself – from the exit of the lower tie plate assembly to the exit at the upper tie plate assembly – about 11 psi of pressure drop usually occurs. When new fuel bundles are introduced into the reactor core, these flow resistances must be preserved [emphasis added]. Otherwise, the coolant/moderator flow distribution could be compromised among the various types of fuel in the reactor core.

It should be noted that the '640 patent also teaches square channels rather than the rounded channel of a venturi (Column 6 starting at Line 66.) The reference thus

not only teaches away from Applicants' invention, the flow through holes of the '640 reference do not have a profile substantially of a venturi and definitely do not have a flaring at the lower face of the nozzle comprising a series of a plurality of concentric countersinks of different included angles and depths. Furthermore, the reference does not teach that the flaring of the lower face of the nozzle plate comprise a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods.

The '650 patent also teaches a boiling water reactor tie plate having openings for the flow of coolant. The patent also acknowledges the need to maintain a relatively large pressure drop to assure the uniform distribution of coolant moderator flow through the many fuel bundles within the core. The patent recognizes changes that have been made to improve the fuel assemblies over time, such as increasing the number of fuel rods with reduced diameters, that results in an increase in pressure drop within the main portion of the assembly. Therefore, the '650 reference strives to make up for that increased pressure drop by reducing the pressure drop within the lower tie plate. The flow through openings are formed in the lower surface of the tie plate between bosses 36 that support the fuel rods. The bosses are connected by webs 38 that have the flow through openings 42 defined in part by convex portions of adjacent bosses, and intervening web portion between the adjacent bosses, marginal edges of a pair of ribs 52 and the marginal edges of the ribs 54 (Column 8, Lines 7 *et seq.*) The openings 42 are generally U-shaped in plan. The legs of the generally U-shaped opening extend toward the center of the square matrix defined by the bosses 36 or towards the center of the central region 50, which is the hub of the web 38 (Column 8, Lines 17-22). Below the throat 56, which is defined as the narrowest

point of the flow through opening 42, and at the entrance of each of the openings 42, there is provided a radius 58 along the margin of each U-shaped opening (Column 8, Line 29-31). Thus the flow through openings of the ‘650 patent are not venturi-like at all, but merely have rounded edges at the inlets.

The ‘634 patent also describes a unitary one-piece lower tie plate grid for a boiling water reactor, having a lower portion and an upper portion for supporting the fuel rods. The lower tie plate grid includes cylindrical boss portions extending upwardly from the lower grid portion and arranged in square matrices for receiving the lower end plugs of the fuel rods. Web portions extending upwardly from the lower tie plate portion interconnect the boss portions along the sides of the matrices much like the ‘650 patent. The lower grid portions include a plurality of openings which open into the flow spaces defined by the convex portion of the bosses and the webs within each square matrix of the upper portion of the tie plate. Coolant flows through the openings into the flow spaces for further flow upwardly about the fuel rods. The openings are radiused adjacent their lower ends and have divergent sidewalls downstream of the throat area to define a flow venturi. However, the profile of the venturi does not have flaring ends wherein the flaring at the lower face of the tie plate comprises a series of a plurality of concentric countersinks of different included angles and depths into the coolant flow through hole. In paragraph 7 of the Office Action of November 16, 2005, which the Examiner incorporated by reference into the Office Action of July 18, 2006, the Examiner relied upon Figure 5 of the ‘634 patent, Figures 13, 15, 17 of the ‘640 patent, Figure 5 of the ‘650 patent and Figure 5E of the ‘621 patent as showing discrete chamfers at the inlet of the flow through hole. With one exception, each of the cited figures shows a rounded inlet which is clearly not formed from a series of a plurality of concentric countersinks of different

included angles and depths into the coolant flow through hole. The one exception is Figure 5E of the ‘621 patent which shows a single chamfer at the inlet and accordingly, does not meet this limitation as well.

The Examiner relies upon the argument that the curved surface is made up of a large number of straight, discrete, adjacent points and therefore falls within the scope of the claim language. While Claim 1 has been amended to recite in different terms the same structure, the original language of Claim 1 appears in varying forms in independent Claims 12 and 13. Thus, it is worthwhile addressing the Examiner’s argument. While the curved surface may be made up of an infinite number of points, and while the tangent of any of those points might be considered straight, the curve itself is not made up of a plurality of straight, discrete, adjacent chamfers and it is believed a stretch of the definition of chamfer to call any of those points a chamfer. A “chamfer” is defined in Webster’s New Collegiate Dictionary as a beveled edge.

2. Claim 2. Claim 2 is dependent on Claim 1 and further defines the flow through hole as having a chamfer in the outlet end. As previously stated, Shallenberger shows a single chamfer at the inlet with no chamfer at the outlet. Neither the ‘621 patent, the ‘650 patent, the ‘634 patent or the ‘640 patent describe, teach or show a chamfer at the outlet. The closest art is found in Figure 5D of the ‘621 patent which shows a chamfer slightly less than midway through the flow through hole. Thus, the reference does not teach a chamfer at the outlet. The corresponding discussion can be found in Column 7 starting at Line 17, which is a continuation of a discussion of a variation of a two-step flow hole that is started in Column 6 starting at Line 28. Accordingly, Claim 2 distinguishes for the individual limitation that introduces and should be considered patentable over the references.

3.       Claims 7-11. Claims 7-11 are either directly or indirectly dependent upon Claim 1 and distinguish over the references for the reasons given with regard to Claim 1.

4.       Claim 12. Claim 12 calls for a debris filter bottom nozzle with flow through holes having a profile substantially of a venturi with flaring at both ends wherein the flaring at the lower face comprises a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods. Thus, Claim 12 calls for the same flow through hole profile described in Claim 1, in different terms, and therefore distinguishes for the reasons previously noted for Claim 1.

B.       Claims 4, 6 and 13-17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger as modified by any of the '621, '640, '650, or '634 patents as applied to Claims 1, 2 and 7-12 above, further in view of the teachings of the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958. The relevant teachings of Shallenberger and the Johansson et al. references have been fully set forth above. As previously stated, Figure 7 of Shallenberger and Figure 5E of the '621 patent are the closest art cited in that they each show a single inlet chamfer and none of the references thus far applied show an outlet chamfer. The Mechanical Engineers' Handbook section referenced discusses the properties of liquids in motion and general considerations regarding flow. The sections cited by the Examiner more particularly deal with discharges through nozzles and make short references to a venturi meter. The corresponding passages discuss the velocity head and flow through different nozzles. On page 3-63, the reference discusses the value of an average good, smooth, rounded orifice as compared to one of poor curvature, with one of poor curvature causing contraction and cross currents

with a significantly lower Hamilton Smith's coefficient. On page 3-64, the reference discusses that rounding or beveling a sharp upstream edge even slightly increases the discharge of an orifice. On the same page, the sections on "Obtainable Precision" and "Submergence or Discharge Under Water" show that the upstream environment of an orifice significantly affects the discharge and flow characteristics. Nothing in the cited text would lead one of ordinary skill to apply a venturi design to the lower nozzle of a fuel assembly. However, if one did, the Mechanical Engineers' Handbook would validate the approach taken in the Johansson et al. references in providing a rounded inlet and outlet. There is no mention in any of the reference of employing a multiple chamfered inlet in combination with a chamfered outlet. Furthermore, none of the references teach the impact of such a design on the manufacturing process.

1. Claim 4. Claim 4 is dependent upon Claim 1 and distinguishes over Shallenberger and the Johansson references for the reasons noted above. As stated in the previous paragraph, the Mechanical Engineers' Handbook does not cure the deficiencies previously noted for Shallenberger and the Johansson et al. references.

2. Claim 6. Claim 6 is dependent upon Claim 4 and specifies the specific angles of the chamfers with regard to the axis of flow, which is neither described, taught or shown in Shallenberger or in any of the Johansson et al. references, nor described in the Mechanical Engineers' Handbook. As mentioned at the bottom of page 8 and the top of page 9 of the specification, the inventors have found through computational fluid dynamics and experimentation that as little as two straight chamfers, if configured properly, could develop flow similar to the curved geometry and result in a similar reduced pressure drop, with much less manufacturing

cost. None of these angles are described, shown or taught in any of the foregoing references.

3. Claim 13. Claim 13 is an independent claim that calls for at least some of the coolant flow through holes having a discrete double chamfered inlet with adjacent chamfers at different angles to the axial direction of the fuel rods. As previously stated, none of the cited references to Shallenberger, Johansson et al. or the Mechanical Engineers' Handbook show the combination of a double chamfered inlet and chamfered outlet. Accordingly, Applicants' Claim 13 should not be considered obvious over the reference.

4. Claims 14 and 15. Claim 14 is dependent upon Claim 13 and calls for the double chamfered inlet approximating a curved surface. Claim 15 is dependent upon Claim 13 and further defines that all of the coolant flow holes not associated with a guide thimble include the double chamfered inlet. Claims 14 and 15 distinguish for the reasons noted for Claim 13 and should be similarly allowable.

5. Claims 16 and 17. Claims 16 and 17 are dependent upon Claim 13 and set forth the specific angles and depths of the chamfers. As stated with regard to Claim 6, none of these angles are described, taught or shown in any of the cited references. Accordingly, Claims 16 and 17 should be allowable for the individual limitations that they introduce.

C. Claims 1, 2, 4 and 6-17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958.

The cited section in the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, is entitled “Venturis” in the chapter on Fluid Dynamics. The excerpt provided by the Examiner is a small portion of that section and does not give the entire context. The first paragraph reads:

Venturi meters are generally made from castings machined to close tolerances to duplicate the performance of the standard design, so they are heavy, bulky, and expensive. The conical diffuser section downstream from the throat gives excellent pressure recovery; overall head loss is low. Venturi meters are self-cleaning because of their smooth internal contours.

The remaining paragraph and a half discusses the high discharge coefficients and the sizing of the meter. It is not clear from any of these teachings that the benefits of a conical diffuser section at the outlet would not be negated by the obstruction of the lower-most grid in the path of the exiting flow. There is clearly no teaching or suggestion in the excerpt of the Mechanical Engineering Handbook, CRC Press LLC, 1999, to employing a conical diffuser section to the outlet of a flow through hole in the lower nozzle of a pressurized water reactor fuel assembly. Furthermore, there is no teaching or suggestion in Shallenberger to such an arrangement nevertheless in combination with a multiple chamfered inlet as called for in Applicants’ claims.

While the Industrial Burners Handbook, CRC Press LLC, copyright 2003 discusses fluid flow in Chapter 3, it does so in an entirely different environment. It is respectfully asserted that one of ordinary skill in the nuclear art would not go to the Industrial Burners Handbook for ideas to resolve issues with regard to the pressure drop in or the manufacturability of the lower nozzle of a pressurized water reactor fuel assembly. Nevertheless, for the purpose of this response, the relevant Section 3.3.3 will be discussed. The section discusses the eduction process commonly carried out by systems known as eductors or jet pumps. Jet pumps are not commonly used within the core of a pressurized water reactors, though they are employed within the reactor

vessels of boiling water reactors. The reference states that it is common to see more complex venturi designs in the burner art. The inlet typically consists of a well-rounded bell design to reduce pressure losses as the secondary gas enters into the eductor system. Reducing pressure losses improves entrainment performance which can be critical to pre-mixed burners. The relative dimensions of the venturi throat downstream of the inlet is also critical to the entrainment performance of the eductor system. Located just downstream of the venturi throat is the diffuser section, which is conical in shape and provides a transition from the venturi throat to the downstream section. Typically, diffusers are designed with small transition angles to provide smooth flow in order to reduce the pressure losses as gas flows from the throat to the downstream section. The downstream section can be a straight pipe or can be quite complex, consisting of a variety of fittings. The reference states:

Usually, in the burner industry, the outlet of the downstream section consists of a tip. There are a variety of tips used in the burner industry, depending on the design application. The pressure loss associated with the flowing gas through the downstream section and tip can have a major influence on the design and performance of an eductor system.

It's not clear what the Industrial Burners Handbook adds to the teachings provided by the Mechanical Engineering Handbook, CRC Press LLC, 1999. The Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958, has already been discussed above.

The Tucker et al. reference is concerned with maintaining a laminar flow in an elongated fluid passage within a device with parallel opposed sides and a flared entry portion leading to a portion of constant cross-section. The device is employed for measuring fluid flow rate and/or viscosity. The device is said to differ from other known apparatus in that the geometry of the entry portion into a substantially constant cross-section passage or passages is defined in terms of a "figure of merit" by means

of a test which may be readily conducted by those skilled in the art. The figure of merit can determine the relative suitability of the inlet design for maintaining laminar flow through the long section of constant cross-section. Figures 5 to 16 are section side views of different entry portions to that of Figure 2, some of which are suitable and others of which are unsuitable for use with the Tucker invention for the purpose of measuring fluid flow rate and/or viscosity. Figure 2 shows a flared rounded entry portion 12. Figure 11 shows a single chamfered inlet and the corresponding description in Column 17 starting at Line 37 states:

In Figure 11, there is shown a fluid passage 2 in accordance with the present invention having a chamfered inlet portion. Any depth D will give an improvement over the squared inlet portion shown in Figure 8. Figures 13, 14 and 16 show that any rounding of the chamfered section provides further improvement over the squared inlet portion shown in Figure 8.

Figure 15 of the reference shows a double chamfered inlet and states in Column 17 starting at Line 63 that:

In Figure 15 there is shown a fluid passage 2 according to the present invention having a double chamfered inlet portion with upstream angle having a steeper angle than the downstream chamfer. Such double chamfering of the inlet would also improve the figure of merit relative to the entry portion in Figure 11 provided that the angle of the second chamfer is not steeper than the angle of the single chamfer of Figure 11.

Figure 16 shows a rounded, flared entry portion where the radius of curvature of the flare changes in magnitude over at least a portion of the inlet length. The reference states that the flow velocity gradients throughout the flared entry portion may be minimized by appropriately contouring the inlet portion in this manner. The gradual and continuous increase in the radius of curvature of the flare in the direction for fluid flow gives good results in terms of the figure of merit.

Thus, even if one was to apply the teachings of Tucker et al. to Shallenberger, Tucker et al. would lead one to the use of rounded inlets as provided in Johansson et al. It does not appear that the outlet was a consideration of Tucker et al.'s

1. Claim 1. Thus in view of the foregoing it should not rightfully be considered obvious to combine the teachings of Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958, to design the flow through hole of the top plate of a fuel assembly bottom nozzle for a pressurized water reactor to have a profile that comprises a plurality of concentric countersinks of different included angles and depths into the coolant flow through hole as claimed in Applicants' Claim 1.

2. Claim 2. Furthermore, in view of the foregoing it should not rightfully be considered obvious to combine the teachings of Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958 to design the flow through hole that combines the flow through hole profile of Claim 1 in combination with an exit chamfer as called for in Claim 2. That is especially the case when none of the cited references teach the combination or even suggest the combination of such teachings.

3. Claim 4. Claim 4 is dependent on Claim 1 and distinguishes for the reasons noted for Claim 1 above.

4. Claim 6. Claim 6 sets forth the particular optimum parameters for the Chamfers which are not described, taught or shown in any of the references of

record and further distinguish for the individual limitations that it introduces.

Accordingly, Claim 6 should not rightfully be considered obvious over the teachings of Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958.

5. Claims 7-11. Claims 7-11 are either directly or indirectly dependent on Claim 1 and distinguish for the reasons noted for Claim 1.

6. Claim 12. Claim 12 defines the profile of a flow through hole in the top plate of a lower nozzle of a pressurized reactor fuel assembly as comprising a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods. Claim 12 distinguishes for the reasons noted above for Claim 1 and should not rightfully be considered obvious over the teachings of Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958.

7. Claim 13. Claim 13 calls for a pressurized water reactor fuel assembly having flow through holes in the upper plate of the bottom nozzle having a profile comprising a discrete, double chamfered inlet with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer relative to the axial direction of the fuel rods. Claim 13 similarly distinguishes for the reasons noted for Claim 1, above and should not rightfully be considered obvious over Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press

LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958.

8. Claim 16. Claim 16 calls for the specific parameters of the inlet chamfers, which are not described or taught in any of the references of record and, therefore should not rightfully be considered obvious over Shallenberger in view of either the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc. copyright 1958.

9. Claim 17. Claim 17 calls for the parameters of the inlet chamfers called for in Claim 6 and distinguishes for the reasons noted above for Claim 6. Accordingly, Claims 1, 2, 4 and 6-17, which were discussed above, should not rightfully be considered obvious over Shallenberger, in view of the Mechanical Engineering Handbook, CRC Press LLC, copyright 1999, or the Industrial Burners Handbook, CRC Press LLC, copyright 2003, or the Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958, and further in view of either Mechanical Engineers' Handbook, Sixth Edition, McGraw-Hill Book Company, Inc., copyright 1958 or Tucker, et al.

D. Claim 5. Claim 5 is rejected under 35 U.S.C. §103(a) as being unpatentable over Shallenberger in view of the teachings of Chapter 42, Fluid Measurements of the Engineering Handbook, CRC Press LLC, copyright 2000. Claim 5 specifies the specific angles of the chamfers relative to the axis of flow. The Examiner asserted that the inlet Chamfer A falls within the range set forth in Shallenberger in the rejection of Section 10 of the Office Action. Shallenberger

discloses a single inlet chamfer forming an angle of about 12-15°. Chamfer A, which is located directly at the inlet and corresponds most closely to Shallenberger's chamfer, is specified in Claim 5 to be approximately 35°. As previously stated, Shallenberger does not describe, teach or show a double chamfered inlet. The only chamfered inlet shown in the Johansson et al. patents is provided with regard to Figure 5E in the '621 patent which also shows a single chamfered inlet; however, no angle of the chamfer is described, taught or shown. The Mechanical Engineers' Handbook, copyright 1958, does not discuss any chamfer angles. The only reference to double chamfer angles is not found in the references cited in Section 10 of the Office Action but may be found in Tucker et al. with regard to the description of Figure 15 in Column 17 starting at Line 66 where the reference states:

Such double chamfering of the inlet portion would also improve the figure of merit relative to the entry portion in Figure 11 provided that the angle of the second chamfer is not steeper than the angle of the single chamfer of Figure 11.

The angle of the single chamfer of Figure 11 is not disclosed. However, the single chamfer of Shallenberger is about 12-15° while the second chamfer of Claim 5 may be between 12 and 18°. Accordingly, the second chamfer of Claim 5 may well be steeper than the single chamfer of Shallenberger, contrary to the teachings of Tucker et al. Furthermore, the teachings of the angle of the diffuser between 5 and 15° in the Engineering Handbook, CRC Press LLC, 2000, is not at the outlet as called for in Claim 5. Accordingly, Claim 5 should not rightfully be considered obvious over Shallenberger, and further in view of the teachings of Chapter 42, Fluid Measurements, of The Engineering Handbook, CRC Press LLC, copyright 2000.

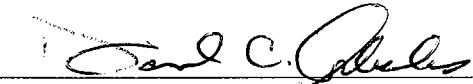
E. In regard to all the foregoing §103 rejections It is respectfully asserted that the Examiner is using hindsight reconstruction to pick and choose among isolated

disclosures in the many pieces of prior art the Examiner has cited to deprecate the claimed invention, which should be, and is, impermissible.

**Conclusion**

Accordingly, in view of the foregoing, Appellants respectfully request that the Board reverse the Examiner's rejections under 35 U.S.C. §§112 and 103(a). It is submitted that Claims 1-2 and 4-17 are patentable over the prior art and satisfy the formal requirements of the patent laws. Therefore, it is requested that the Board reverse the Examiner's rejections of Claims 1-2 and 4-17 and remand the application to the Examiner for the issuance of a Notice of Allowance.

Respectfully submitted,

  
\_\_\_\_\_  
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## CLAIMS APPENDIX

### Listing of Claims:

1. A fuel assembly for a pressurized water nuclear reactor including a plurality of elongated nuclear fuel rods having an extended axial length, at least a lowermost grid supporting said fuel rods in an organized array and having unoccupied spaces defined therein adapted to allow flow of fluid coolant therethrough and past said fuel rods when said fuel assembly is installed in the nuclear reactor and a plurality of guide thimbles extending along said fuel rods through and supporting said grid, a debris filter bottom nozzle disposed below said grid, below lower ends of said fuel rods, supporting said guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate extending substantially transverse to the axis of the fuel rods and having an upper face directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design being a plurality of holes receiving lower ends of said guide thimbles where they are supported by said plate and the second hole design being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and in the extended direction at least some of said coolant flow through holes having a profile substantially of a venturi with flaring at both ends, wherein the flaring at the lower face of said plate comprises a series of a plurality of concentric countersinks of different included angles and depths into the coolant flow through hole.
2. The nuclear fuel assembly of Claim 1 wherein said coolant flow through holes having a profile substantially of a venturi have an inlet end in the lower face of said plate and an outlet end in the upper face of said plate wherein the venturi is substantially formed by the concentric countersinks of different included angles and depths into the coolant flow through hole in said inlet and a chamfer in said outlet end.
3. (canceled)

4. The nuclear fuel assembly of Claim 1 wherein the inlet chamfers approximates a curved surface.

5. The nuclear fuel assembly of Claim 4 wherein the chamfers have the following dimensions and angles relative to a flow axis of the flow through hole where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and Chamfer C is at the outlet of the flow through holes.

	Angle	Nominal Length (in.)	Maximum Length (in.)	Minimum Length (in.)
Chamfer A	$35^\circ \pm 3^\circ$	0.017 (0.043 cm)	0.039 (0.099 cm)	0.012 (0.030 cm)
Chamfer B	$15^\circ \pm 3^\circ$	0.039 (0.099 cm)	0.057 (0.145 cm)	0.010 (0.025 cm)
Chamfer C	$10^\circ \pm 3^\circ$	0.085 (0.361 cm)	0.142 (0.361 cm)	0.059 (1.397 cm)

6. The nuclear fuel assembly of Claim 4 wherein the chamfers have the following relative dimensions and angles with regard to a flow axis of the flow through hole where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and Chamfer C is at the outlet of the flow through holes and L/T is the length of the chamfer divided by the thickness of the plate.

	Angle	Chamfer L/T	
		Maximum	Minimum
Chamfer A	$2.33 \times B$	0.071	0.020
Chamfer B	$15^\circ +/- 3^\circ$	0.104	0.017
Chamfer C	$0.67 \times B$	0.258	0.101

7. The nuclear fuel assembly of Claim 1 wherein substantially every coolant flow through hole not associated with a guide thimble has the venturi profile in the extended direction.

8. The nuclear fuel assembly of Claim 1 including support means adapted to support said fuel assembly when installed in the nuclear reactor with said plate fixed at its periphery on said support means.
9. The nuclear fuel assembly of Claim 1 wherein the coolant flow through holes have a substantially circular cross-section.
10. The nuclear fuel assembly of Claim 9 wherein the coolant flow through holes have a  $0.190 +/- 0.008$  inch ( $0.48 +/- 0.02$  cm) or less diameter at their narrowest cross-section.
11. The nuclear fuel assembly of Claim 9 wherein the through coolant flow through holes are packed in a density of about 16 per square inch.
12. A debris filter bottom nozzle for a pressurized water nuclear reactor fuel assembly having a plurality of elongated nuclear fuel rods having an extended axial length, at least a lowermost grid supporting said fuel rods in an organized array and having unoccupied spaces defined therein adapted to allow flow of fluid coolant therethrough and past said fuel rods when said fuel assembly is installed in the nuclear reactor, a plurality of guide thimbles extending along said fuel rods through and supporting said grid, said debris filter bottom nozzle designed to be disposed below said grid, below lower ends of said fuel rods, to support said guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate extending substantially transverse to the axis of the fuel rods and having an upper face to be directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design being a plurality of holes for receiving lower ends of said guide thimbles where they are to be supported by said plate and the second hole design being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes when incorporated in said fuel assembly, extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and in the

extended direction at least some of said coolant flow through holes having a profile substantially of a venturi with flaring at both ends, wherein the flaring at the lower face of said plate comprises a series of a plurality of straight, discrete, adjacent chamfers with each adjacent chamfer at a different angle than another adjacent chamfer relative to the axial direction of said fuel rods.

13. A fuel assembly for a pressurized water nuclear reactor including a plurality of elongated nuclear fuel rods having an extended axial length, at least a lowermost grid supporting said fuel rods in an organized array and having unoccupied spaces defined therein adapted to allow flow of fluid coolant therethrough and past said fuel rods when said fuel assembly is installed in the nuclear reactor, a plurality of guide thimbles extending along said fuel rods through and supporting said grid, a debris filter bottom nozzle disposed below said grid, below lower ends of said fuel rods, supporting said guide thimbles and adapted to allow flow of fluid coolant into said fuel assembly, said debris filter bottom nozzle comprising a substantially horizontal plate extending substantially transverse to the axis of the fuel rods and having an upper face directed toward said lowermost grid, said upper face of said plate having defined therethrough at least two different hole designs, the first hole design being a plurality of holes receiving lower ends of said guide thimbles where they are supported by said plate, the second hole design being a plurality of flow through holes extending completely through said plate for the passage of coolant fluid from a lower face of said plate to the upper face of said plate, each of said coolant flow through holes extending substantially in the axial direction of said fuel rods, in fluid communication with said unoccupied spaces, and at least some of said coolant flow through holes having a discrete, double chamfered inlet with each adjacent chamfer of the double chamfered inlet at a different angle than the other adjacent chamfer relative to the axial direction of said fuel rods.

14. The nuclear fuel assembly of Claim 13 wherein the double chamfered inlet approximates a curved surface.

15. The nuclear fuel assembly of Claim 13 wherein all of the coolant flow through holes not associated with a guide thimble include the double chamfered inlet.

16. The nuclear fuel assembly of Claim 13 wherein the chamfers have the following dimensions and angles relative to a flow axis of the flow through hole where Chamfer A is the chamfer closest to an inlet of the flow through hole and Chamfer B is the chamfer adjacent Chamfer A, spaced from the inlet.

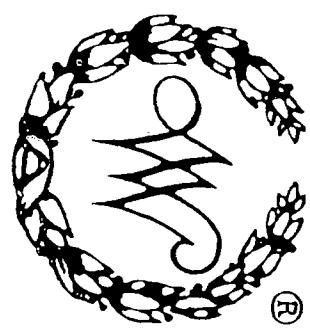
	Angle	Nominal Length (in.)	Maximum Length (in.)	Minimum Length (in.)
Chamfer A	$35^\circ \pm 3^\circ$	0.017 (0.043 cm)	0.039 (0.099 cm)	0.012 (0.030 cm)
Chamfer B	$15^\circ \pm 3^\circ$	0.039 (0.099 cm)	0.057 (0.145 cm)	0.010 (0.025 cm)

17. The nuclear fuel assembly of Claim 13 wherein the chamfers have the following relative dimensions and angles with regard to a flow axis of the flow through hole where Chamfer A is the chamfer closest to the inlet, Chamfer B is the chamfer adjacent Chamfer A and L/T is the length of the chamfer divided by the thickness of the plate.

	Angle	Chamfer L/T	
		Maximum	Minimum
Chamfer A	$2.33 \times B$	0.071	0.020
Chamfer B	$15^\circ \pm 3^\circ$	0.104	0.017

## **EVIDENCE APPENDIX**

WEBSTER'S



New  
Collegiate  
Dictionary

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## concelebrant • concise

**ce mark** — used for communications serial satellite  
äk-ə-rē also **käm-** *n* [Anthony Comstock] censorious opposition to alleged immoralities in the theater (*Comstockery*, an idiotic and ... Mencken)

äk-ə-an also **käm-** *adj* : of or relating to

1. **käm(p)-tē-on**, **kō-n(t)-ē-** *adj* : of or Comte or his doctrines — **Comtist** *\käm(p)-tast, n*

1: conning [ME *connen* to know, learn, to know, infin. of *can* — more at CAN] 1 closely: PERUSE 2: to commit to memory

**contra**: on the negative side: in opposition written pro and ~) 2: the negation or evidence in opposition 2: the negating it (an appraisal of the pros and ~s)

**consing** [*Conc.*] 1: SWINDELE 2: PERSUADE, CA-

suming] slang: a destructive disease of the **osis** 2 consolidated 3 consul 4 **jux**] **consort** 2 consolidated 3 consul 4

1. **mör-ē**, **kō-nā-mör-(j)ā**, **-mör-** *adv* [It] 1, or zest 2: in a tender manner — used as a

1. **mä**, **kō-nän-i-** *adv* [It, lit., with spirit]: in with animation — used as a direction in music

**hōn** [*L. conation*, *conatio* act of attempting, *nari* to attempt — more at DEACON] : an inclinat, a drive, a wish, or a craving to act purposefully

**con-a-na-tion-al** \shnäl, -shn-*l* *adj* — co-na-

ät-, **kän-ot-** *adj* 1 *n* **conatus** \sh-*z*, -nä-, -nä-, -nät-, **nat-** *adj* : a natural tendency, effort, fr. *conatus*, pp.] : a natural tendency,

1. **kō-n-** *adv* [It, lit., with vigor]: in a vigorous used as a direction in music

entrance; concentrated; concentration 2 concrete **kän-kä-nav-a-lan** *n* [com- + *canavalin* (a non-

in found in the jack bean), fr. NL *Canavalia*, *the jack bean*: either of two crystalline globulins

ick bean]: either of two crystalline globulins **ick bean**: one that is a potent hemagglutinin

\kän-kat-ə-not, **kän-** *adj* [ME, fr. LL *concatenare* to link together, fr. L *com- + catena* CHAIN]: linked together

**nat-** *vt* — **nat-ed**; **nat-ing** : to link together in a **con-cale-nation** \(\kän-kat-ə-nä-shän, kän-

**käv**, **kän-** *adj* [MF, fr. *concavus*, fr. *com-* + more at CAVE] 1: hollowed or rounded inward i a bowl 2: arched in: curving in — used of the surface on which neighboring normals to the converge and on which lies the chord joining two points of the curve or surface

**-käv** *n*: a concave line or surface in **ka-vat-ə** *n*, **pl** **ties** 1: a concave line, surface

2: the quality or state of being concave

**cave** \kän-kä-\vo\ *adj* : concave on both sides

**ex adj** 1: concave on one side and convex on the other side curved more than the convex

\sé(ə)\ *vt* [ME *conceler*, fr. MF *concler*, fr. L *co-* + *celare* to hide — more at HELL] 1: to prevent

recognition of 2: to place out of sight **syn** see **RE-**

**ceal-able** \sh-ə-bal\ *adj* — **con-ceal-er** \sh-ə-

**ceal-ingly** \sh-ə-lin-lē\ *adv* — **con-ceal-ment** \sh-

1. **séd** *vb* **conceded**; **conced-ing** [F or L: *concedere*, fr. *com- + cedere* to yield — more at CEDER] 1: a right or privilege 2 **a**: to accept as true, the right of the state to tax is generally conceded edge grudgingly or hesitantly ~vi: to make con-

**syn** see GRANT **ant** deny — **conced-ed-y**

**con-cer-n** *n* [ME, fr. *conceiver*] 1 **a** (1): a rea-

lity: THOUGHT (2): individual opinion **b**: favor:

excessive appreciation of one's own worth or ific idea **b**: an elaborate or strained metapho-

re of such conceits in poetry 3: a fancy ar-

1 obs: CONCEIVE, UNDERSTAND 2 **dial**: IMAG-

o take a fancy to

\sh-ət-əd\ *adj* [conceit] 1: ingeniously con-

2: having an excessively high opinion of one's self **con-cie-ness** *n*

**ile** \kän-sé-va-bal\ *adj* : capable of being con-

3LE — **con-ceiv-a-bil-i-ty** \kän-sé-va-bil-i-tē\ *ness* \sh-ə-bal-nas\ *n* — **con-ceiv-ably** \sh-

\kän-sev\ *vb* **conceived**; **con-ciev-ing** [ME *conceive*, fr. L *concipere* to take in, conceive, fr.

take — more at HEAVE] *vt* 1 **a**: to become

b: to cause to begin: ORIGINATE 2 **a**: to form mind (~ a prejudice against him) **b**: to form

**IMAGINE, IMAGE** 3: to apprehend by reason

UNDERSTAND 4: to be of the opinion ~vi: to

gnant 2: to have a conception — usu. used with emptiness) **syn** see THINK — **conceive**

**con-cele-brant** \kän-sel-a-bränt, kän-\ *n*: one that concelebrates a Eucharist or Mass

**con-cele-brate** \kän-sel-a-brä-t, kän-\ *vb* [L *concelebratus*, pp. of *concelebre* to celebrate in great numbers, fr. *com- + celebre* to celebrate] *vt* : to participate in (a Eucharist) as a joint celebrant who recites the canon in union with other celebrants ~vi: to participate as a celebrant in a co-celebrated Eucharist — **con-cele-bration** \(\kän-sel-a-brä-shän, kän-\

**con-cep-tion** \kän-sent\ *n* [L *concentus*, fr. *concentus*, pp. of *concinere* to sing together, fr. *com- + centre*] *vt* : to draw or direct to a common center: CONCENTRATE ~vi: to come to a common center

**con-cen-trate** \kän(t)-san-, trät-, -sen-\ *vb* [com- + L *centrum* center] *vt* 1 **a**: to bring or direct toward a common center or objective: FOCUS **b**: to gather into one body, mass, or force (power was concentrated in a few able hands) 2 **a** : to make less dilute (~ syrup) **b**: to separate a valuable material from (~ an ore) **c**: to express or exhibit in condensed form ~vi 1: to draw toward or meet in a common center 2: GATHER, COLLECT 3: to concentrate one's powers, efforts, or attention (~ on a problem) — **con-cen-tra-tive** \sh-trät-iv\ *adj* — **con-cen-trator** \sh-trät-ər\ *n*

**con-cen-trate** *n*: something concentrated **con-cen-tra-tion** \kän(t)-san-, träs-, -sen-\ *n* 1: the act or process of concentrating: the state of being concentrated; **specif**: direction of attention to a single object 2: a concentrated mass or thing 3: the relative content of a component: STRENGTH **concentration** **camp** *n*: a camp where persons (as prisoners of war, political prisoners, or refugees) are detained or confined **con-cen-tric** \kän-sen-trik\, \sh-ən-trik\ *adj* [ML *concentricus*, fr. L *com- + centrum* center] 1: having a common center (~ circles) 2: having a common axis: COAXIAL **con-cen-tric-ic** \sh-ən-trik\ *adj*

**con-cep-tion** \kän-sent\ *n* [L *conceptum*, neut. of *conceptus*, pp. of *concipere* to conceive] 1: something conceived in the mind ~THOUGHT, NOTION 2: an abstract or generic idea generalized from particular instances **syn** see IDEA

**con-cep-tacle** \kän-sep-ti-käl\ *n* [NL *conceptaculum*, fr. L *receptacle*, fr. *receptus*, pp. of *concipere* to take in]: an external cavity containing reproductive cells in algae (as of the genus *Fucus*) **con-cep-tion** \kän-sep-shän\ *n* [ME *conception*, fr. OF *conception*, fr. L *conceptionis*, conceptio, fr. *conceptus*, pp. of *concipere* to take in, conceive] 1 **a** (1): the act of becoming pregnant: the state of being conceived (2): EMBRYO, FETUS **b**: archaic: BEGINNING (joy had the like ~ in our eyes —Shak.) 2 **a**: the capacity, function, or process of forming or understanding ideas or abstractions or their symbols **b**: a general idea: CONCEPT **c**: a complex product of abstract or reflective thinking **d**: the sum of a person's ideas and beliefs concerning something 3: the originating of something in the mind **syn** see IDEA — **con-cep-tion-al** \sh-ən-əl\ *adj* — **con-cep-tive** \sh-əv\ *adj* — **con-cep-tual** \sh-ə-wäl\ *adj* — **con-cep-tually** \sh-ə-wäl-ə-tü\ *adv*

**con-cep-tual-iz-a-tion** \sh-ə-wäl-ə-zā-shän, -shän\ *n* — **con-cep-tual-ize** \sh-ə-wäl-ə-zë, -zë\ *vt* — **con-cep-tual-ity** \sh-ə-wäl-ə-tē\ *n* — **con-cep-tual-ly** \sh-ə-wäl-ə-tü\ *adv*

**con-cep-tual-iz-a-tion** \sh-ə-wäl-ə-zā-shän, -shän\ *n* — **con-cep-tual-ize** \sh-ə-wäl-ə-zë, -zë\ *vt* — **con-cep-tional** \sh-ə-nəl\ *adj* — **con-cep-tional-ly** \sh-ə-nəl-ə-tü\ *adv*

**con-cep-tual-ist** \sh-ə-nəst\, \sh-ə-näst\ *n* [F *conceptuel*, fr. *conceptus*, pp. of *concepere* to conceive] 1: one that operates a refreshment stand at a recreational center **con-cep-tion-er** \kän-sep-shän-ə-närt\ *n*: CONCESSIONAIRE **con-cep-tive** \sh-ə-vës\, \sh-ə-vëz\ *adj* 1: making for or being a concession 2: denoting concession (a ~ clause) — **con-cep-tive-ly** *adv*

**conch** \känk\, \känch\, \könk\, \könch\ *n* [L *concha* mussel shell, fr. Gr. *konchē*; akin to Skt *sankha* conch shell] 1: any of various large spiral-shelled marine gastropod mollusks (as of the genera *Strombus* and *Cassis*); also: its shell used esp. for cameos 2: CONCHA 2: CONCH or CONCHOL abbr. conchology

**conch** or **concho** *comb form* [Gk *konch-*, *kon-*, fr. *konchē*] : shell (conchology) *conchiolin* **concha** \känk\, \känch\, \könk\, \könch\ *n*, **pl** **conchae** \sh-ə-kē, -kē, -kī\ [L & L; fr. *conca* semide, apse, fr. LL *concha*, fr. L, shell] 1: the plain semide of an apse b: APSE 2: something shaped like a shell; esp.: the largest and deepest concavity of the external ear — **con-chal** \sh-ə-käl\ *adj*

**con-chi-olin** \kän-ki-ə-lən, kän-\ *n* [conch- + -ol + -in]: a scleroprotein forming the organic basis of mollusk shells

**con-cho-dal** \kän-koid\, \kän-\ *adj* [Gk *konchoeidēs* like a mussel, fr. *konchē*]: having elevations or depressions shaped like the inside surface of a bivalve shell — **con-cho-dally** \sh-əl-ē\ *adv*

**con-chol-o-gy** \kän-käl-ə-jē\, \sh-ə-jē\ *n*: a branch of zoology that deals with shells 2: a treatise on shells — **con-chol-o-gist** \sh-ə-jist\ *n*

**con-cierge** \kön-syärzh\, \sh-ərzh\ *n* [F *conciere* *servus* slave, fr. com- + servus slave] 1: a resident in an apartment building esp. in France who serves as doorkeeper, landlord's representative, and janitor 2: a usu. multilingual hotel staff member esp. in Europe who handles luggage and mail, makes reservations, and arranges tours for the guests

**con-cili-ar** \kön-sil-ē-ər\, \sh-əl-ē-ər\ *adj* [L *concilium* council]: of, relating to, or issued by a council — **con-cili-ar-ly** *adv*

**con-cili-ate** \kän-sil-ē-ət\, \sh-ət\ *vt* — **at-ing** [L *conciliatus*, pp. of *conciliare* to assemble, unite, win over, fr. *concilium* assembly, council — more at COUNCIL] *vt* 1: to gain (as goodwill) by pleasing acts 2: to make compatible: RECONCILE 3: APPEASE ~vi: to become friendly or agreeable — **con-cili-a-tion** \sh-ə-tēshən\ *n* — **con-cili-a-tive** \sh-ə-ētiv\ *adj* — **con-cili-a-tor** \sh-ə-tör\ *n* — **con-cili-a-to-ry** \sh-əl-yə-tör-ē, \sh-ə-ē-tör-ē, \sh-ə-ē-tör\ *adj*

**con-cin-ni-ty** \kän-sin-at-əv\, *n*, **pl** **ties** [L *concinna*, fr. *concinus* skillfully put together]: harmony and often elegance of design esp. of literary style in adaptation of parts to a whole or to each other

**con-cise** \kän-sis\ *adj* [L *concisus*, fr. pp. of *concidere* to cut up, fr. com- + caedere to cut, strike] akin to MHG *hele* mallet, Arm *xait* to prick] 1: marked by brevity of expression or statement: free

joined in an integrated whole — compare BALLET, OPERA — **in concert**: TOGETHER (he worked in concert with others)

**con-cert-ed** \kän-sert-əd\, *adj* 1 **a**: mutually contrived or agreed on (a ~ effort) **b**: performed in unison (~ artillery fire) 2: arranged in parts for several voices or instruments — **con-cert-ed-ly** *adv* — **con-cert-ed-ness** *n*

**con-cert-go-er** \kän(t)-sart-gō(-ə), \kän-, sart-\ *n*: one who frequently attends concerts

**con-cert grand** \kän(t)-sart-, \kän-, sart-\ *n*: a grand piano of the largest size adapted in volume, timbre, and brilliance of tone to concert use

**con-cert-i-na** \kän(t)-sar-tē-nā\, *n* 1 **a**: a musical instrument of the accordion family 2: a coiled barrel wire for use as an obstacle

**con-cep-ti-no** \kän-chär-tē(-)nō\, *n*, **pl** **-nos** [It, dim. of *concerto*] 1: the solo instruments in a concerto grosso 2: a short concerto

**con-cert-i-ze** \kän(t)-sar-tiz\, *vi* — **ized**: *-izing* **to**: to perform professionally in concerts

**con-cert-me-ster** \kän-mi-star\, \sh-ə-mi-star\ *n* [G *konzertmeister*, fr. *Konzert* concert + *meister* master]: the leader of the first violins of an orchestra and by custom usu. the assistant to the conductor

**con-cep-tor** \kän-chert\, \sh-ər\, \sh-ər\ *n*, **pl** **ti** \sh-ər\, \sh-ər\ [It, *con-cep-tore*] : one or more soloists and orchestra usu. in symphonic form with three contrasting movements

**concer-to** \kän-chert\, \sh-ər\, \sh-ər\ *n*, **pl** **ti** \sh-ər\, \sh-ər\ [It, big concerto]: a baroque orchestral composition featuring a small group of solo instruments contrasting with the full orchestra

**concer-to gros-so** \sh-ərō(-)sō\, *n*, **pl** **concerti gros-si** \sh-ərō(-)sē\ [It, lit, big concerto]: a baroque orchestral composition featuring a small group of solo instruments contrasting with the full orchestra

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concertina 1

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**concer-to gros-so** \sh-ərō(-)sō\, *n*, **pl** **concerti gros-si** \sh-ərō(-)sē\ [It, lit

nt ~ 7 : the act of lease or dismissal esp. separation from military or electric power of the chemical

1 discharge of electric  
the enclosed vapor or  
d gas is enhanced by

contains gas or vapor at  
n takes place when a  
living flowers with the

val in shape  
& OF *descrip*, fr. LL  
it in his lifetime, fr. L  
preaching the doctrines  
inner circle of Christ's

b : a convinced ad-  
ember of the Disciples  
olds the Bible alone to  
immersion, and has a  
ER — *disciple-ship*

n- adj 1 : DOGILE,  
plike (a ~ offense)  
ine who disciplines or

3-*plain-ə-rē* adj 1 a  
1 to correct or punish  
of or relating to a par-  
dis-*pla-ner-əl* adv

L; MF, fr. L *disciplina*  
is : INSTRUCTION 2 : a  
training that corrects,  
moral character 4  
enforcing obedience or  
pattern of behavior c  
governing conduct or

uish or penalize for the  
y instruction and exer-  
a group) under control  
e writer ~s and refines  
inner n

discipline (a ~ mind)  
TV show of popular  
ments not related to the

dis- + *claimer* to claim,  
2 a obs : to disavow  
1 to renounce a legal

r, v.] 1 a : a denial or  
of or formal refusal to  
g that embodies a legal  
REPUTATION  
UNCINATION, DISAVOWAL

ly stable ecological com-  
is foreign to the region  
bance esp. by man  
MF *desclos-*, stem of  
open, fr. L *dis- + clau-*  
to open up 2 a : to  
make known or public  
t (demands that politi-  
see REVEAL — *dis-clo-*

or an instance of disclos-  
REVELATION  
UE

that compiles discogra-

aphie, fr. *disc- + -graphic*  
aph records by category,  
2 : the history of re-  
-ko-*graf-i-kal* also dis-  
al-ly *-i-kɔ̄lə* adv  
out-shaped, fr. Gk *diskos*  
isk or discus : being flat  
disk as a composite flower head

ing, or producing a disk:  
horns form a flat coil b  
disklike areas

en, fr. MF *descolurer*, fr.  
color, fr. *dis- + color* vt  
~ vi : to change color

1 : the act of discoloring  
colored spot or formation

lat<sup>1</sup> vt lat-ed : *lat-ing*  
NFUSE (the offensive had  
we arrangements —A. J.

b-(y)-a-*la-shən* n

'*dis-com-fit* \dis-kom(p)-fat, esp South *dis-kom-fit* \ vt [ME *dis-comfitem*, fr. OF *desconfir*, pp. of *desconfire*, fr. *des- + confire* to prepare — more at *COMFIT*] 1 a *archaic* : to defeat in battle b : to frustrate the plans of : THWART 2 : to put into a state of perplexity and embarrassment : DISCONCERT syn see EMBARRASS

'*dis-com-fit* n : DISCOMFITURE  
*dis-com-fi-ture* \dis-kom(p)-fa-chū(ə)r-, -char, -t(y)ū(ə)r\ n : the act of discomfitting ; the state of being discomfited

'*dis-com-fort* \dis-kam(p)-fərt\ vt [ME *discomfort*, fr. MF *desconfort*, fr. OF, fr. *des- + conforter* to comfort] 1 *archaic* : DIS-  
MAY 2 : to make uncomfortable or uneasy — *dis-com-for-table* \-kam(p)-fərt-ə-bal, -kam(p)(f)-tər-bal\ adj — *dis-com-for-ter* \-kam(p)-fərt-ər\ n

'*dis-com-fit* n : DISTRESS, GRIEF 2 : mental or physical uneasiness : ANNOYANCE (he gave every sign of intense ~)

'*dis-com-mend* \dis-kam(m)-mend\ vt 1 : DISAPPROVE, DISPARAGE 2 : to cause to be viewed unfavorably — *dis-com-mend-able* \-men-də-bal\ adj — *dis-com-men-da-tion* \(\dis-kam-an-dā-shən, -kam-ən-\) n

'*dis-com-mode* \dis-ka-mōd\ vt —mod-ed; -mod-ing [MF *discommoder*, fr. fr. *dis- + mode* convenient — more at *COMMODE*] : to cause inconvenience to : TROUBLE

'*dis-com-pose* \dis-kam-pōz\ vt 1 : to destroy the composure or serenity of 2 : to disturb the order of — *dis-com-po-sure* \-pō-zhər\ n

syn DISCOMPOSE, DISQUIET, DISTURB, PERTURB, AGITATE, UPSET, FLUSTER, FLURRY shared meaning element : to destroy or impair one's capacity for collected thought or decisive action *ant* compose

'*dis-con-cer-tar* \dis-kan-sər\ vt [obs. F *disconcerter*, alter. of MF *desconcerter*, fr. *des- + concerter* to concert] 1 : to throw into confusion 2 : to disturb the composure of syn see EMBARRASS —

'*dis-con-cert-ing* adj — *dis-con-cert-ing-ly* \-i-jə-lē\ adj : to establish as invalid : DISPROVE

'*dis-con-form-a-ble* \dis-kan-for-mə-bal\ adj : of or relating to a

disconformity in rocks — *dis-con-form-a-bly* \-bəlē\ adv

'*dis-con-form-i-ty* \dis-kan-for-mətē\ n 1 *archaic* : NONCONFORMITY 2 : a break in a sequence of sedimentary rocks all of which have approximately the same dip

'*dis-con-nect* \dis-ka-nekt\ vt 1 : to sever the connection of or between ~vi 1 : to terminate a connection 2 : to become detached or withdrawn (he has periods when he ~s into silences — Current Biog.)

'*dis-con-nected* adj : not connected : INCOHERENT — *dis-con-*

*nect-ed-ly* adv — *dis-con-nect-ed-ness* n

'*dis-con-so-late* \dis-kan(t)sə-lət\ adj [ME, fr. ML *disconsolatus*, fr. L *dis- + consolatus*, pp. of *consolari* to console] 1 : DEJECTED, DOWNCAST (the team returned ~ from three losses) 2 : CHEERLESS (a clutch of ~ houses —D. H. Lawrence) — *dis-con-so-lately* adv — *dis-con-so-late-ness* n — *dis-con-so-la-tion* \(\dis-kan(t)sə-lə-shən, -shən\)

'*dis-con-tent* \dis-kan-tənt\ adj : DISCONTENTED

'*discontent* n : one who is discontented : MALCONTENT

'*discontent* vt : to make discontented — *dis-con-tent-ment* \-mənt\ n

'*discontent* n : lack of contentment: a : a sense of grievance : DISSATISFACTION (the winter of our ~ —Shak.) b : restless aspiration for improvement

'*dis-con-tent-ed* adj : DISSATISFIED, MALCONTENT — *dis-con-tent-ed-ly* adv — *dis-con-tent-ed-ness* n

'*dis-con-tin-u-ance* \dis-kan-tin-yo-wən(t)s\ n 1 : the act or an instance of discontinuing 2 : the interruption or termination of a legal action by failure to continue or by the plaintiff's entry of a discontinuing order

'*dis-con-tin-ue* \dis-kan-tin-(y)ū, -yo(-w)\ vb [ME *discontinuen*, fr. MF *discontinuer*, fr. ML *discontinuare*, fr. L *dis- + continuare* to continue] vt 1 : to break the continuity of : cease to operate, administer, use, or take 2 : to abandon or terminate by a legal discontinuance ~vi 1 : to come to an end; specif : to cease publication syn see STOP, CONTINUE

'*dis-con-tin-u-ity* \(\dis-kan-tin-(y)ū,-tē\ n 1 : lack of continuity or cohesion 2 : GAP 3 : a value of an argument at which a function is not continuous

'*dis-con-tin-uous* \dis-kan-tin-yo-wəs\ adj 1 a (1) : not continuous (a ~ series of events) (2) : not continued : DISCRETE (~ features of terrain) b : lacking sequence or coherence (this ~ style) 2 : having one or more discontinuities — used of a variable or a function — *dis-con-tin-uously* adv

'*dis-co-phile* \dis-kɔ̄fīl\ n : one who studies and collects phonograph records

'*dis-coord* \dis-kō(ə)rd\ n 1 a : lack of agreement or harmony (as between persons, things, or ideas) b : active quarreling or conflict resulting from discord among persons or factions : STRIFE 2 a (1) : a combination of musical sounds that strike the ear harshly (2) : DISSONANCE b : a harsh or unpleasant sound

'*dis-coord* syn DISCORD, STRIFE, CONFLICT, CONTENTION, DISSENSION, DIFFERENCE, VARIANCE shared meaning element : the state of those who disagree and lack harmony or the acts and circumstances marking such a state

'*dis-coord* \dis-kō(ə)rd\, dis-\ n [ME *disorderen*, fr. OF *disorderer*, fr. *dis- + ordre* disorder, fr. *disordre*, *disordre* discord, fr. *dis- + cord*, *cord* heart — more at HEART] : DISAGREE, CLASH

'*dis-coord-ance* \dis-kōrd-əns\ n 1 : the state or an instance of being discordant 2 : DISSONANCE

'*dis-coord-anc-y* \-n-sē\ n, pl -cies : DISCORDANCE

'*dis-coord-ant* \-ənt\ adj 1 a : being at variance : DISAGREEING b : RELATIVE 2 : relating to a discord — *dis-coord-antly* adv

'*dis-coord-i-nate* \dis-kōrd-i-nāt\, dis-kōrd-i-nāt\ n [F *discoordonner*, fr. *dis- + coordonner* + -ate] 1 : a small lounge, nightclub for dancing to live or recorded music; broadly a nightclub often featuring psychedelic and mixed-media attractions (as slides, movies, special lighting effects, and kinetic sound)

'*dis-count* \dis-kaunt\ n 1 : a reduction made from the gross amount or value of something: as a (1) : a reduction made from the gross amount or list price (2) : a proportionate deduction from a debt

## discomfit • discrete

account usu. made for cash or prompt payment b : a deduction made for interest in advancing money upon or purchasing a bill or note due 2 : the act or practice of discounting 3 : a deduction taken or allowance made

'*dis-count* \dis-kaunt\ n [modif. of F *décompter*, fr. L *dis- + computare* to count — more at COUNT] vt 1 a : to make a deduction from usu. for cash or prompt payment b : to sell or offer for sale at a discount 2 : to lend money on after deducting the discount 3 a : to leave out of account : DISREGARD b : to underestimate the importance of : MINIMIZE c (1) : to make allowance for bias or exaggeration in (2) : to view with doubt : DISBELIEVE d : to take into account (as a future event) in present calculations ~ vi : to give or make discounts

'*dis-count-a-ble* \dis-kaunt-ə-bal, 'dis-\ adj 1 : capable of being discounted (a ~ note) 2 : set apart for discounting (within the ~ period)

'*dis-cou-n-te-nance* \dis-kaunt'-n-ən(t)s\ n 1 : DISABIL, DISCONCERT 2 : to look with disfavor on : discourage by evidence of disapproval

'*discount-er* \dis-kaunt-ər, dis-\ n : one that discounts; specif : DISCOUNT STORE

'*discount-hou-se* n : DISCOUNT STORE

'*discount-rate* n 1 : the interest on an annual basis deducted in advance on a bank or other loan 2 : the charge levied by a central bank for advances and rediscouts

'*discount-store* n : a store where merchandise (as consumer durable goods) is sold at a discount from suggested list price

'*dis-course* \dis-kōrs\, -kōr(s), -kōr(s)\ vt [aged; ag-ing] [MF *descorager*, fr. OF *descorager*, fr. des-dis- + corage courage] 1 : to deprive of courage or confidence : DISHEARTEN 2 a : to hinder by disfavoring : DETE 2 b : to attempt to dissuade — *dis-course-able* \-bəl\ adj — *dis-course-er* n

'*dis-course-ment* \-mənt\ n 1 : the act of discouraging : the state of being discouraged 2 : something that discourages : DETERRANT

'*dis-course-ing* adj : lessening courage : DISHEARTENING — *dis-course-ingly* \-i-jə-lē\ adv

'*dis-course* \dis-kōrs\, -kōr(s), -kōr(s)\ n [ME *discours*, fr. ML & LL *discursus*; ML, argument, fr. LL, conversation, fr. L, act of running about, fr. *discurrere* to run about, fr. *dis- + currere* to run — more at CAR] 1 *archaic* : the capacity of orderly thought or procedure : RATIONALITY 2 : verbal interchange of ideas; esp : CONVERSATION 3 a : formal and orderly and usu. extended expression of thought on a subject b : connected speech or writing 4 *obs* : social familiarity

'*dis-course-ing* \dis-kōrs\, -kōr(s), -kōr(s)\ n 1 : to express oneself esp. in oral discourse 2 : TALK, CONVERSE ~ vi, archaic : to give forth : UTTER — *dis-course-er* n

'*dis-course-ous* \('dis-kōrt-əs\, -kōr(s)\) adj : lacking courtesy : RUDE — *dis-course-ously* adv — *dis-course-ous-ness* n

'*dis-course-sy* \('kōrt-əsē\ n 1 : RUDENESS 2 : a rude act

'*dis-cover* \dis-kōvər\ vb *dis-cover-ed*; *dis-cover-ing* \-'kōvər(i)n\ [ME *discoveren*, fr. OF *descovrir*, fr. LL *discooperire*, fr. L *dis- + cooperire* to cover — more at COVER] vt 1 a : to make known or visible : EXPOSE b *archaic* : DISPLAY 2 : to obtain sight or knowledge of for the first time : FIND (~ the solution of a puzzle) ~vi 1 : to make a discovery — *dis-cover-able* \-'kōvər(i)-əbəl\ adj — *dis-cover-er* \-ər\ n syn 1 see REVEAL

2 DISCOVER, ASCERTAIN, DETERMINE, UNEARTH, LEARN shared meaning element : to find out something not previously known to one 3 see INVENT

'*dis-cover-y* \dis-kōv-(ə)rē\ n, pl -ries 1 a : the act or process of discovering b (1) *archaic* : DISCLOSURE (2) *obs* : DISPLAY c *obs* : EXPLORATION 2 : something discovered

'*Discovery Day* n : COLUMBUS DAY

'*dis-cred-it* \('dis-krēt\) vt 1 : to refuse to accept as true or accurate : DISBELIEVE 2 : to cause disbelief in the accuracy or authority of 3 : to deprive of good repute : DISGRACE

'*dis-cred-it* n 1 : loss of credit or reputation (I knew stories to the ~ of England —W. B. Yeats) 2 : lack or loss of belief or confidence : DOUBT (contradictions cast ~ on his testimony)

'*dis-cred-it-able* \-ə-bal\ adj : injurious to reputation — *dis-cred-itably* \-bli\ adv

'*dis-creet* \dis-krēt\ adj [ME, fr. MF *discret*, fr. ML *discretus*, fr. L, pp. of *discernere* to separate, distinguish between — more at DISCERN] 1 : having or showing discernment or good judgment in conduct and esp. in speech : PRUDENT; esp : capable of preserving prudent silence 2 : UNPRENTIOUS, MODEST (the warmth and ~ elegance of a civilized home —Joseph Wechsberg) — *dis-creetly* adv — *dis-creet-ly* adv

'*dis-crepan-cy* \dis-krep-ən-sē\ n, pl -cies 1 : the quality or state of being discrepant : DIFFERENCE 2 : an instance of being discrepant

'*dis-crep-ant* \-ənt\ adj [L *discrepant*, *discrepare*, prop. of *discrepare* to sound discordantly, fr. *dis- + crepare* to rattle, creak — more at RAVEN] : being at variance : DISAGREEING (widely ~ conclusions)

'*dis-crete* \dis-krēt\, dis-\ adj [ME, fr. L *discretus*] 1 : constituting a separate entity : individually distinct 2 a : consisting of distinct or unconnected elements : NONCONTINUOUS b : taking on or having a finite or countably infinite number of values : not mathe-

a abut \* kitten ar further a back ā bake ā cot, cart  
ā out ch chin e less ē easy g gift i trip ī life  
j joke g sing ū flow ū flaw ū coin th thin th this  
ū loot ū foot y yet ū few ū furious zh vision

### **discreetly • disguise**



### 1. discuss 1a

ashore out of a ship 2 : to get out of a vehicle — **dis-em-bar-ka-tion** \dɪs'əm'bər-kā'shən, -bär'-n/

**dis-em-bar-a-sis** \dɪs'əm'bər-əs\ vt : to free from something troublesome or superfluous **syn** see EXTRICATE

**dis-em-body** \dɪs'am'bād\ vt : to divest of a body, of corporeal existence, or of reality

**dis-em-bogue** \dɪs'əm'bōg\ vb -boqued: -boguing [modif. of Sp *desembocar*, fr. *des-* + *embarcar* to put into the mouth, fr. *en* in (fr. *L* *in*) + *boca* mouth, fr. *L* *bucca* — more at *POCK*] vi : to flow or come forth from or as if from a channel ~ vt : to pour out : EMPTY

**dis-em-bow-el** \dɪs'am'bōōl\ vt 1 : to take out the bowels of ~: EVISCERATE 2 : to remove the substance of — **dis-em-bow-el-ment** \mənt\ n

**dis-en-chant** \dɪs'ən'chant\ vt [MF *desenchanter*, fr. *des-* + *enchanter* to enchant] : to free from illusion — **dis-en-chan-tor** \dɪs'ən'chan-tər\ n

**dis-en-chant-ing** adj — **dis-en-chant-ing-ly** \iŋ'lē\ adv — **dis-en-chant-ment** \mənt\ n

**dis-en-cum-ber** \dɪs'ən'kəm'bər\ vt [MF *desencombrer*, fr. *des-* + *combrer* to encumber] : to free from encumbrance : DISBURDEN

**syn** see EXTRICATE

**dis-en-dow** \dɪs'ən'dau\ vt : to strip of endowment — **dis-en-dow-er** \dau'zər\ n ~: **dis-en-dow-ment** \dau'mənt\ n

**dis-en-fran-chise** \dɪs'ən'frān'chiz\ vt : DISFRANCHISE — **dis-en-fran-chise-ment** \chiz'mənt, -chəz'\ n

**dis-en-gage** \dɪs'ən'gāj\ vb [F *desengager*, fr. MF, fr. *des-* + *engager* to engage] vt : to release from something that engages ~ vi : to release or detach oneself : WITHDRAW — **dis-en-gage-ment** \mənt\ n

**dis-en-tail** \dɪs'ən'tāl\ vt : to free from entail

**dis-en-tan-gle** \dɪs'ən'tāng'gəl\ vt : to free from entanglement : UNRAVEL ~ vi : to become disentangled **syn** see EXTRICATE **ant** entangle — **dis-en-tan-gle-ment** \mənt\ n

**dis-en-thrall** also **dis-en-thral** \dɪs'ən'thrōl\ vt : to free from bondage : LIBERATE

**dis-equil-i-brate** \dɪs'əkwil'əbrāt\ vt : to put out of balance — **dis-equil-i-bration** \dɪs'əkwil'əbrāshən\ n

**dis-equil-i-rium** \dɪs'əkwil'əriəm\ n ~: loss or lack of equilibrium

**dis-es-tab-lish** \dɪs'əstāb'lish\ vt : to deprive of an established status; esp : to deprive of the status and privileges of an established church — **dis-es-tab-lish-ment** \mənt\ n

**dis-es-tab-lish-men-tar-i-an** \dɪs'əstāb'lish-mən'tēərēən\ n often cap [disestablishment] : one who opposes an established order — **disestablishmentarian** adj, often cap

**dis-es-teem** \dɪs'əstēm\ vt : to regard with disfavor

**dis-eat-e-nism** \dɪs'əētēn'izm\ n DISREPUTE

**dis-euse** \dɪs'əz(r)z, -züz\ n pl **dis-euses** \dɪs'əz(r)z(-z), -züz(-z)\ [F, fem. of *diseur*, fr. OF, fr. *dire* to say, fr. L *dicere* — more at DICTION] : a skilled and usu. professional woman reciter

**dis-fa-vor** \dɪs'fāvər\ n [prob. fr. MF *desfaivre*, fr. *des-* + *faveur* favor, fr. OF *favor*] 1 : DISAPPROVAL, DISLIKE (practices looked upon with ~) 2 : the state or fact of being deprived of favor (fell into ~) 3 : DISADVANTAGE

**dis-favor** vt : to withhold or withdraw favor from

**dis-fa-ture** \dɪs'fāchər\ vt : to mar the features of **syn** see DEFACE — **dis-fa-ture-ment** \mənt\ n

**disfig-ure** \dɪs'fig'yr, esp Brit \dɪs'fig'yr\ vt [ME *disfiguren*, fr. MF *desfigurer*, fr. *des-* + *figure*] 1 : to impair (as in beauty) by deep and persistent injuries (as girl disfigured by smallpox) 2 obs: **dis-gui-se** **syn** see DEFACE — **dis-figure-ment** \mənt\ n

**dis-fran-chise** \dɪs'frān'chiz\ vt : to deprive of a franchise, of a legal right, or of some privilege or immunity; esp : to deprive of the right to vote — **dis-fran-chise-ment** \chiz'mənt, -chəz'\ n

**dis-rock** \dɪs'fräk\ vt : UNFROCK

**dis-func-tion** var of **PYSFUNCTION**

**dis-furnish** \dɪs'far-nish\ vt [MF *desfourniss-*, stem of *desfournir*, fr. *des-* + *fournir* to furnish — more at FURNISH] : to make destitute of possessions — **dis-fur-nish-ment** \mənt\ n

**dis-gorge** \dɪs'gorj\ vt [MF *desgorger*, fr. *des-* + *gorge*] 1 a : to discharge by the throat and mouth : VOMIT b : to discharge violently, confusedly, or as a result of force c : to give up on quest or under pressure (refused to ~ his ill-gotten gains) 2 obs: **dis-gor-gement** \gorj'mēnt\ n

**dis-grace** \dɪs'grās\ n [MF, fr. Olt *disgrazia*, fr. *dis-* (fr. L) + *grazia* grace] 1 a : loss of grace, favor, or b : the condition of one fallen from grace or honor 2 : something that disgraces (that boy's manners are a ~)

**syn** DISGRACE, DISHONOR, DISREPUTE, SHAME, INFAMY, IGNOMINY, OPPROBRIUM **shared meaning element**: loss of esteem and repute and the resulting denigration and contempt **ant** respect, esteem

**dis-grace-ful** \dɪs'grās'fəl\ adj : bringing or involving disgrace

**dis-grace-fully** \dɪs'grās'fəlē\ adv — **dis-grace-fulness** n

**dis-gruntle** \dɪs'grant'l\ vt ~: **dis-grun-tled**; **dis-grunt-ling**, **-lēn** \dɪs'grant'lin, -lēn\ vt ~: to grumble, fr. MF *desgrunter* freq. of *grunter* to grunt; to make ill-humored or discontented (the workers are disgruntled with their wages) — **dis-grunt-ment** \mənt\ n

**dis-guis-e** \dɪs'giz\ vt **dis-guised**: **dis-quisi-ing** [ME *disguiser*, fr. OF, fr. *des-* + *guise*] 1 a : to change to a formal dress or appearance of b : to furnish with a false existence or assumed identity 2 obs: **disFIGURE** 3 : to conceal **syn** DISGUISE, CLOAK, MASK, DISSEMBLE **shared meaning element**, alter so as to hide the true appearance, identity, intent, ing, or feelings



## sequined • serious

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**sequined** or **se-quinned** \kwoond\ adj : ornamented with or as if with sequins  
**se-qui-tur** \sek-wat-ar, -wa-tu(r)o\ n [L, it follows, 3d pers. sing. pres. indic. of *sequi* to follow — more at SERU] : the conclusion of an inference : CONSEQUENCE  
**se-quoia** \si-kwoi(y)o\ n [NL, genus name, fr. *Sequoya* (George Guess) †1843 Am Indian scholar] : either of two huge coniferous California trees of the pine family that reach a height of over 300 feet: a: BIG TREE b: REDWOOD 3a  
**ser abbr** 1 serial 2 series 3 service  
**sera** pl of SERUM  
**serac** \sa-rak, sa\ n [F *sérac*, lit., a kind of white cheese, fr. ML *seracum* whey, fr. L *serum* whey — more at SERUM] : a pinnacle, sharp ridge or block of ice among the crevasses of a glacier  
**sera-glio** \sa-ral-yo\ n, pl -glots [It. *serraglio* enclosure, seraglio, partly fr. ML *serrulum* bar of a door, bolt; fr. LL *serare* to bolt; partl. fr. Turk *saray* palace — more at SEAR] 1: Harem 2: a palace of a sultan  
**serai** \sa-ri\ n [Turk & Per; Turk *saray* mansion, palace, fr. Per *sarai* mansion, inn] 1: CARAVANSARY 2: SERAGLIO 2  
**ser-al** \sir-o\ adj : of, relating to, or constituting an ecological series  
**ser-a-pe** \sa-rap-e, -rap-e\ n [MexSp *sarape*] : a colorful woolen shawl worn over the shoulders esp. by Mexican men  
**ser-ap-h** \sir-ap-h\ also **ser-a-phim** \sir-ap-him\ n, pl **seraphim** or **seraphs** [LL *seraphim*, pl. *seraphs*, fr. Heb *śeraphim*] 1: one of the 6-winged angels standing in the presence of God 2 pl: an order of angels — see CELESTIAL HIERARCHY — **seraph-ic** \sir-ap-ik\ adj — **seraphi-cally** \i-k(i)-o-ne\ adv  
**Serapis** \sa-ri-pis\ n [L, fr. Gk *Sarapis*] : an Egyptian god combining attributes of Osiris and Apis and having a widespread cult throughout Greece and Rome  
**1Serb** \sirb\ n [Serb *Srb*] 1: a native or inhabitant of Serbia 2: SERBIAN 2 — **2Serb** abbr Serbian  
**Ser-bian** \sir-be-an\ n 1: SERB 1 2 a: the Serbo-Croatian language as spoken in Serbia b: a literary form of Serbo-Croatian using the Cyrillic alphabet — **Serbian** adj  
**Ser-bo-Cro-at-ian** \sir-bo-kro-a-shan\ n 1: the Slavic language of the Serbs and Croats consisting of Serbian written in the Cyrillic alphabet and Croatian written in the Roman alphabet 2: one whose native language is Serbo-Croatian — **Serbo-Croatian** adj  
**1ser-e** \sir-i\ adj [ME, fr. OE *sēr* dry; akin to OHG *sōren* to wither, Gk *haus* dry] 1: WITHERED 2 archaic: THREADBARE  
**2ser-e** n [L series] : a series of ecological communities that succeed one another in the biotic development of an area or formation  
**1ser-e-nade** \sir-e-nād\ n [F *serenade*, fr. It *serenata*, fr. L *serena* clear, calm (of weather), fr. L *serenus*] 1 a: a complimentary vocal or instrumental performance; esp.: one given outdoors at night for a woman b: a work so performed 2: an instrumental composition in several movements, written for a small ensemble, and midway between the suite and the symphony in style  
**2serenade** vb -nad-ed; -nading v t: to perform a serenade in honor of ~vi: to play a serenade — **ser-e-nader** n  
**ser-e-na-te** \sir-e-nāt\ n [It. *serenata*] : an 18th century secular cantata of a dramatic character usu. composed in honor of an individual or event  
**ser-en-di-pi-tous** \sir-an-dip-i-tos\ adj : obtained or characterized by serendipity (<~discoveries>) — **ser-en-di-pi-tous-ly** adv  
**ser-en-di-pi-ty** \dip-i-ti\ n [fr. its possession by the heroes of the Per fairy tale *The Three Princes of Serendip*] : the faculty of finding valuable or agreeable things not sought for  
**1ser-e-ne** \sir-e-nē\ adj [L *serenus*; akin to OHG *serawēn* to become dry, Gk *xeros* dry] 1 a: clear and free of storms or unpleasant change (<~ skies>) b: shining bright and steady (the moon, ~in glory — Alexander Pope) 2: marked by or suggestive of utter calm and unruffled repose or quietude (a ~ smile) 3: AUGUST — used as part of a title (*His Serene Highness*) **syn** see CALM — **se-re-ne-ly** adv — **se-re-ne-ness** \rē-nas\ n  
**2serene** n 1: a serene condition or expanse (as of sky, sea, or light) 2: SERENITY, TRANQUILLITY  
**se-ren-i-ty** \sir-e-nit\ n: the quality or state of being serene  
**serf** \sirf\ n [F, fr. L *servus* slave, servant, serf — more at SERVE] : a member of a servile feudal class bound to the soil and subject to the will of his lord — **serf-age** \sirf-ij\ n — **serf-dom** \sirf-dom, -dom\ n  
**serf or sergt abbr sergeant**  
**serge** \sirj\ n [ME *sarge*, fr. MF, fr. (assumed) VL *sarica*, fr. L *serica*, fem. of *sericus* silken — more at SERICEOUS] : a durable twilled fabric having a smooth clear face and a pronounced diagonal rib on the front and the back  
**ser-geant** \sir-jant\ n: the function, office, or rank of a sergeant  
**ser-geant** \sir-jant\ n [ME, servant, attendant, sergeant, fr. OF *sergent*, *serjant*, fr. L *servient*, servens, pp. of *servire* to serve] 1: SERGEANT AT ARMS 2 obs: an officer who enforces the judgments of a court or the commands of one in authority 3: an officer in a police force ranking in the U.S. just below captain or sometimes lieutenant and in England just below inspector 4: a noncommissioned officer ranking in the army and marine corps above a corporal and below a staff sergeant and in the air force above an airman first class and below a staff sergeant; broadly: NONCOMMISSIONED OFFICER  
**sergeant at arms**: an officer of an organization (as a legislative body or court of law) who preserves order and executes commands  
**sergeant first class** n: a noncommissioned officer in the army ranking above a staff sergeant and below a master sergeant  
**sergeant fish** n 1: COBIA 2: SNOOK 1  
**sergeant major**, n, pl **sergeants major** or **sergeant majors** 1: a noncommissioned officer in the army, air force, or marine corps serving as chief administrative assistant in a headquarters 2: a noncommissioned officer in the marine corps ranking above a first sergeant 3: a bluish green to yellow percoid fish (*Abudefduf*

*saxatilis*) with black vertical stripes on the sides that is widely distributed in the western tropical Atlantic ocean

**sergeant major of the army**: the ranking noncommissioned officer of the army serving as adviser to the chief of staff

**sergeant major of the marine corps**: the ranking noncommissioned officer of the marine corps serving as adviser to the commandant

**ser-geanty** \sir-jant\ n, pl -geant-ies [ME *sergeantie*, fr. MF *sergentie*, fr. *sergent* sergeant]: any of numerous feudal services of a personal nature by which an estate is held of the king or other lord distinct from military tenure and from socage tenure

**serg-ing** \sir-jing\ n [serge] : the process of overcasting the raw edges of a fabric (as a carpet) to prevent raveling

**ser-i-al** \sir-e-al\ adj 1: of, relating to, consisting of, or arranged in a series, rank, or row (~ order) 2: appearing in successive parts or numbers (~ a story) 3: belonging to a series maturing periodically rather than on a single date (~ bonds) 4: of, relating to, or being music based on a series of tones in an arbitrary but fixed pattern without regard for traditional tonality (~ technique)

— **se-ri-al-ly** \i-k(i)-o-ne\ adv

**serial** n 1 a: a work appearing (as in a magazine or on television) in parts at intervals b: one part of a serial work : INSTALLMENT 2: a publication (as a newspaper or journal) issued as one of a consecutively numbered and indefinitely continued series

— **se-ri-al-ist** \sir-e-al-ist\ n

**se-ri-al-izm** \sir-e-al-iz-əm\ n : serial music; also: the theory or practice of composing serial music

**se-ri-aliza-tion** \sir-e-al-i-zā-shon\ n : the act or process of serializing

**se-ri-alize** \sir-e-al-i-z\ vt -ized; -izing: to arrange or publish in serial form

**serial number** n: a number indicating place in a series and used as a means of identification

— **1se-ri-al-ate** \sir-e-at, -ē-at\ adj [(assumed) NL *seriatus*, fr. L *series*] : arranged in a series or succession — **2se-ri-al-ate** \sir-e-ē-at, -ē-at\ vt -ated; -ating: to arrange in a series

— **1se-ri-a-tim** \sir-e-ā-tim\ n, -at\ adv [ML, fr. L *series*] : in a series

**2se-ri-a-tion** adj: following seriatim

**se-ri-ces** \sir-e-s\ adj [LL *sericeus* silken, fr. L *sericum* silk garment, silk, fr. neut. of *sericus* silken, fr. Gk *serikos*, fr. *Seres*, an eastern Asiatic people producing silk in ancient times] : finely pubescent (~ leaf)

**ser-i-cin** \sir-a-sin\ n [ISV, fr. L *sericum* silk] : a gelatinous protein that cements the two fibroin filaments in a silk fiber

**ser-i-culture** \sir-e-kul-chur\ n [L *sericum* silk + E culture] : the production of raw silk by raising silkworms — **ser-i-cul-tur-al** \kälch(-ä)-ral\ adj — **ser-i-cul-tur-al-ly** \rast\ n

**series** \sir-ez\ n, pl **series** often attrib [L, fr. *serere* to join, link together; akin to Gk *eirein* to string together, *hormos* chain, necklace] 1: a number of things or events of the same class coming one after another in spatial or temporal succession (~ concert ~) (the hall opened into a ~ of small rooms) 2: the indicated sum of a usu. infinite sequence of numbers 3 a: the coins or currency of a particular country and period b: a group of postage stamps in different denominations 4: a succession of volumes or issues published with related subjects or authors, similar format and price, or continuous numbering 5: a division of rock formations that is smaller than a system and comprises rocks deposited during an epoch 6: a group of chemical compounds related in composition and structure 7: an arrangement of the parts or elements in an electric circuit whereby the whole current passes through each part or element without branching 8: a set of vowels connected by ablaut (as i, a, u in ring, rang, rung) 9 a: a number of games (as of baseball) played usu. on consecutive days between two teams (in town for a 3-game ~) b: WORLD SERIES 10: a group of successive coordinate sentence elements joined together (as a, b, and c ~) 11: SOIL SERIES 12: three consecutive games in bowling — in **series** : in a serial arrangement

**series winding** n: a winding in which the armature coil and the field-magnet coil are in series with the external circuit — **se-ri-e-**

**wound** \sir-ez-waud\ adj

**ser-if** \sir-if\ n [prob. fr. L *scripere* to write, fr. L *scrivere* to write, fr. L *scribere* — more at SCRIBE] : any of the short lines stemming from and at an angle to the upper and lower ends of the strokes of a letter

**seri-graph** \sir-i-graf\ n [L *sericum* silk + Gk *graphein* to write, draw — more at CARVE] : an original color print made by pressing pigments through a silk screen with a stencil design — **seri-gra-pher** \sir-i-gra-fər\ n — **ser-i-gra-phy** \rē-fē\ n

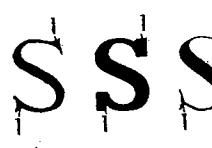
**ser-in** \sir-in\ [F]: a small European finch (*Serinus canarius*) related to the canary

**ser-i-ne** \sir-e-nē\ n [ISV *sericin* + -ine]: a crystalline amino acid  $C_5H_{10}NO_3$  that occurs as a structural part of many proteins or cephalins

**ser-i-comic** \sir-e-o-käm-ik\ adj [serious + -o- + comic]: having a mixture of the serious and the comic (a ~ novel) — **ser-i-comi-cally** \i-k(i)-o-ne\ adv

**ser-i-ous** \sir-e-as\ adj [ME *serious*, fr. MF *serieux*, fr. LL *seriosus*, alter. of L *serius*] 1: thoughtful or subdued in appearance or manner: SOBER 2 a: requiring much thought or work (~ study) b: of or relating to a matter of importance (a ~ play) 3: not joking or trifling: being in earnest b archaic: pious c: deeply interested: DEVOTED (~ fishermen) 4 a: not easily answered or solved (~ objections) b: having important or dangerous possible consequences (a ~ injury)

**syn SERIOUS, GRAVE, SOLEMN, SEDATE, STAID, SOBER, EARNEST** shared meaning element: not light or frivolous **ant** light, flippant



7 serif

se-ri-ou-s  
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New International  
Dictionary  
OF THE ENGLISH LANGUAGE  
UNABRIDGED

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MADE IN THE UNITED STATES OF AMERICA



**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re: application of: ) Group Art Unit 3641  
KIRKLAND D. BROACH et al. )  
Serial No. 10/751,349 ) Examiner: D.L. Greene Jr.  
Filed: January 5, 2004 ) Entitled:  
Attorney Docket No. ARF 2004-003 ) NUCLEAR FUEL ASSEMBLY  
                                  ) DEBRIS FILTER BOTTOM  
                                  ) NOZZLE

**August 30, 2005**

**Eckert Seamans Cherin & Mellott, LLC  
600 Grant Street  
Pittsburgh, PA 15219**

**MAIL STOP RCE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313**

**Declaration Under 37 CFR 1.132**

Sir:

As a supplement to the Request for Continuing Examination and the Preliminary Amendment that are filed concurrently herewith, the following Declaration is offered:

I. Michael Y. Young declare and state:

1. That I received my Bachelor of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute at Troy, New York.
2. That I received my Master of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute .
3. That I worked for Westinghouse Electric Company LLC for 33 years.
4. That as an employee of Westinghouse Electric Company LLC, I currently hold the position of Chief Engineer.

5. That my curriculum vitae outlining the rest of my credentials is attached hereto.

6. That I have read the amended Claim 1 submitted with the amendment that is to accompany this Declaration, the Examiners rejection and the references the Examiner relied on.

7. That I am familiar with the Shallenberger design set forth in U.S. Patent No. 4,900,507, which is assigned to his employer, Westinghouse Electric Company LLC.

8. That the Shallenberger design and the teaching of the Shallenberger patent do not contemplate having a flared outlet at the fuel assembly bottom nozzle coolant flow holes nor does the Shallenberger patent describe or contemplate having a double chamfered inlet, both of which are specified in the amended Claim 1 to be filed concurrently herewith.

9. That the Shallenberger patent was published in 1990 and to the best of my knowledge, information and belief, except for the inventors of the subject application, no one has employed or suggested the use of a double chamfered inlet and flared outlet for the coolant holes in a fuel assembly bottom nozzle, since the publication of the Shallenberger patent.

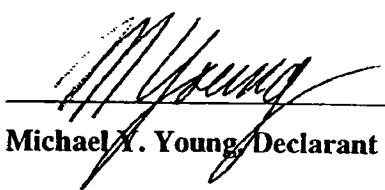
10. That the double chamfered inlet and flared outlet is a novel way to achieve pressure drop reduction near that of a rounded inlet and venturi outlet while meeting numerous constraints imposed by the performance requirements of the nuclear fuel assembly, such as maintenance of uniform flow, and by the manufacturing process, such as closely spaced flow holes and accommodation of tolerances.

11. That none of the references relied upon by the Examiner suggest that a venturi profile for the coolant holes in the bottom nozzle of a fuel assembly will not adversely impact the other coolant criteria that need to be fulfilled for satisfactory coolant transport through the nuclear core.

12. That the double chamfered inlet has been found not to adversely impact the benefit of the venturi profile in the bottom nozzle coolant flow holes, but provides a significant manufacturing savings over the normal venturi gradient profile between the inlet and outlet of the venturi flow holes.

I further declare and state that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

  
Michael A. Young, Declarant

August 30, 2005  
Date

## RESUME

Michael Y. Young  
January 1, 2002

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Email: youngmy@westinghouse.com

### EDUCATION:

BS - Aeronautical Engineering, Rensselaer Polytechnic Institute, Troy, New York. 1966 - 1970

MS - Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, New York. 1970 - 1972

### EXPERIENCE:

2001- 2005: Chief Engineer, Nuclear Fuels

Currently responsible for:

1. Identification of Technological Opportunities for Nuclear Fuels: Lead the process to identify areas where technological opportunities exist, which could produce significant breakthroughs. Utilize this knowledge to focus the organization's technology, research, and development activities.
2. Technical Knowledge Management: As appropriate, ensure that there is continuous organizational leveraging and integration of historical technological solutions and new research & development activities, including:
  - a. Coordination of Development Programs
  - b. Industry interactions to assure consistent positions and approach
  - c. Foster key University relationships
  - d. Review and solicit key technical papers and establish strategy for attending conferences
3. Ensure an organizational understanding of the unmet needs of the nuclear fuel customer (operational, licensing, margins, etc.. Develop actions/plans to address these needs.
4. Facilitate the allocation of funding for development projects, oversee completion of those activities, and monitor progress.
5. Technological Problem Resolution – Where appropriate, lead and/or facilitate technological review teams to review critical technical issues, new designs and services, etc. Serve as the technical final solution in areas of technical disputes and coordinate resolution of these issues. Lead department task teams addressing critical high impact

- issues involving multi-discipline functions.
6. Key Strategic Initiatives – Where appropriate & assigned, lead the implementation of key strategic initiatives which develop high value for customers and NFBÜ. Interface with the Strategy Department to provide key technical strategy input.

1993-2001: Consulting Engineer, Nuclear Services and Nuclear Fuels.

Led team developing Next Generation Fuel grid.

Led team to resolve the V5H grid to rod fretting issue. Outcome was development of the RFA-2 grid design and a more complete understanding of fretting phenomena that should prevent problems in future.

Led multi-division team to resolve the Axial Offset Anomaly issue. Role included defining test and development programs, interactions with customers and EPRI, and development of predictive tool to determine AOA risk of core designs. Outcome was the BOB code, increased understanding of crud deposition and AOA process, and an influential position in the EPRI/Utility AOA working group.

Led team developing the safety case for the AP600 advanced reactor design. Prepared strategy for making presentations to the Advisory Committee on Reactor Safeguards, a key obstacle to approval of the AP600 design.

Led team of experts in 4 year project to develop new computer technology for nuclear safety analysis ("Best Estimate" Loss of Coolant Accident Evaluation Model). Project involved solution of numerous problems in thermal-hydraulics, numerical methods, and probability, and continual interaction and negotiation with Nuclear Regulatory Commission (NRC) and Advisory Committee on Reactor Safeguards (ACRS). Successful licensing of methodology (the first of its kind in the industry) required high degree of credibility in discussions with NRC and ACRS.

1991-1993: Manager, Nuclear Safety Analysis, Westinghouse Energy Systems Business Unit.

Managed technical staff of 6 managers and approximately 100 engineers engaged in safety and engineering analysis. Group was responsible for sales of approximately ten to fifteen million dollars per year. Responsibilities included interactions with customers and NRC to resolve licensing and technical issues, including application of new reporting regulations for computer code changes, and application of 10CFR50.59 safety evaluation process.

1981-1991: Manager, Thermal Hydraulic Testing and Analysis, Westinghouse Energy Systems Business Unit.

Initiated program to develop an advanced Loss of Coolant Accident (LOCA) analysis technology, using statistical methodology.

Managed group of 15 engineers responsible for designing and overseeing the performance of several test and analysis programs, including the FLECHT reflood heat transfer and MB-2 steam generator programs.

Worked with Westinghouse Owner's Group (WOG) to resolve several key issues such as quantifying the extent of radiation release in steam generator tube rupture.

Helped resolve the clad ballooning issue that was a key obstacle in licensing PWRs in the UK.

Successfully obtained approval by NRC for application of improved safety analysis methods (BASH code). These methods allowed Westinghouse to supply new nuclear fuel designs with higher peaking factors than the competition.

1972-1981: Engineer, Westinghouse Nuclear Energy Systems.

Began Westinghouse career as associate engineer in 1972. Helped develop Westinghouse Appendix K LOCA model. Was lead engineer in effort to license Upper Head Injection system for Sequoyah Nuclear Plant. Developed first significant improvement to the Appendix K model for increased LOCA margin (the BART code). Work required frequent presentations and negotiations with NRC staff and other oversight committees.

#### OUTSIDE ACTIVITIES:

1987, 1988 Commissioner, Little League Baseball

1986, 1987, 1988 Coach, Little League Baseball

1985-1989, Member and president of neighborhood pool committee

#### AWARDS:

Division Engineering awards in 1980, 1984, 1987, 1989, 1995, 2000

George Westinghouse company award, 2001.

#### PAPERS:

1. "A Mechanistic Model for the Best Estimate Analysis of Reflood Transients (The BART Code)", 19<sup>th</sup> National Heat transfer Conference, Orlando, Florida, 1980.
2. "Advances in PWR LOCA Analysis", Technical Workshop on Nuclear Reactor Safety and Thermo-hydraulics, Seoul, Korea, 1985.
3. "An Implicit Method to Speed up WCOBRA/TRAC", Nuclear Science and Engineering, 1988.
4. "Application of Realistic Thermal-Hydraulic Methods for Pressurized Water Reactors with Upper Plenum Injection", Nuclear Technology, 1989.
5. "Development of LOCA Margin for Two-Loop PWR", Nuclear Plant Journal, January, 1989.

6. "Downflow Two-Phase Pressure Drop in Irregular Channels with Plates", Int. Symposium on Gas-liquid Two Phase Flows, ASME Winter Annual Meeting, 1990.
7. "Application of PWR LOCA Margin with the Revised Appendix K Rule", Nuclear Engineering and Design, 1992.
8. "Application of code scaling and uncertainty methodology to the large break loss of coolant", Nuclear Engineering and Design, 1998
9. "Assessment of flooding in a best estimate thermal hydraulic code (WCOBRA/TRAC)", Nuclear Engineering and Design, 1998.
10. "Best Estimate Analysis of the large break loss of coolant accident", ICONE-6, 1998
11. "Flooding in the pressurizer surge line of AP600 plant and analyses of APEX data", Nuclear Engineering and Design, 1999.
12. "Direct contact heat transfer model for dispersed flow film boiling", Nuclear Technology, December 2000.
13. "The flow field in a reactor core and its effect on rod vibration and wear", ASME Pressure Vessels and Piping Conference, July 2001.
14. "Flow Induced Vibration and Fretting Wear in PWR Fuel", ICONE 10, April 2002.
15. "The Effect Of Corrosion Product Deposition On Fuel Management", Advances in Nuclear Fuel Management III (ANFM 2003), October 5-8, 2003.
16. "A Comprehensive Method for Assessing Fuel Performance Risks Due to Crud Deposition", Proceedings of the 2004 International Meeting on LWR Fuel Performance, Orlando, Florida, September 19-22, 2004.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re: application of:	)	Group Art Unit 3641
	)	
KIRKLAND D. BROACH et al.	)	Examiner: D.L. Greene Jr.
	)	
Serial No. 10/751,349	)	Entitled:
	)	
Filed: January 5, 2004	)	NUCLEAR FUEL ASSEMBLY
	)	DEBRIS FILTER BOTTOM
Attorney Docket No. ARF 2004-003	)	NOZZLE

**April 6, 2006**

**Eckert Seamans Cherin & Mellott, LLC  
600 Grant Street  
Pittsburgh, PA 15219**

**MAIL STOP AMENDMENT  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313**

**Supplemental Declaration Under 37 CFR 1.132**

Sir:

As a supplement to the Declaration Under 37 CFR 1.132 of Michael Y. Young dated August 30, 2005, in furtherance of allowance of the above captioned matter, the following Declaration is offered:

I, Michael Y. Young, declare and state:

1. That I have reviewed and understand the contents of the specification of the above captioned application, including the claims as amended by the response to the Office action dated November 16, 2005, which accompanies and references this Supplemental Declaration Under 37 CFR 1.132.

2. That fluid dynamics within the core of a nuclear reactor are complicated by the large number of structures in the path of the coolant, the need to continually maintain contact of the coolant with the fuel cladding to avoid reduced heat transfer and the objective of maximizing heat transfer between the fuel elements and the coolant.

3. That Westinghouse has observed an appreciable difference (20%) in hydraulic pressure drop between nozzles fabricated by two different vendors to design specifications based on the Shallenberger patent. Furthermore, Westinghouse's investigation into the differences concluded that the main cause for these differences were minute geometry differences introduced by removing burrs caused by the chamfer machining operations. The inability to specify, measure, and control these minute geometries caused by burr removal, provided impetus to improve upon Shallenberger.

4. That neither Westinghouse, with approximately 30 years experience producing fuel assembly nozzles, nor its outside fabricators found it obvious that the small geometry changes caused by burr removal could result in 20% variation in hydraulic performance.

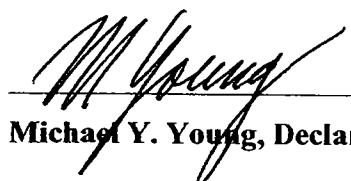
5. That through experimentation Westinghouse found that the double chamfered inlet and flared outlet is a way to achieve pressure drop reduction near that of a rounded inlet and venturi outlet while meeting numerous constraints imposed by the performance requirements of the nuclear fuel assembly, such as consistent and uniform flow between assemblies, reasonable manufacturing costs, closely spaced flow holes, and fabrication tolerances.

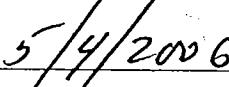
6. That none of the references relied upon by the Examiner suggest that a venturi profile for the coolant holes formed with a double chamfered inlet in the bottom nozzle of a fuel assembly will not adversely impact the other coolant criteria that need to be fulfilled for satisfactory coolant transport through the nuclear core and still provide the hydraulic margin necessary to accommodate surface anomalies that arise in the manufacturing process.

7. That Westinghouse test results have shown that the double chamfered inlet has been found not to adversely impact the benefit of the venturi profile in the bottom nozzle coolant flow holes, but provides a significant manufacturing savings over the normal venturi gradient profile between the inlet and outlet of the venturi flow holes.

I further declare and state that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

**Respectfully submitted,**

  
\_\_\_\_\_  
**Michael Y. Young, Declarant**

  
\_\_\_\_\_  
**Date**

**RELATED PROCEEDINGS APPENDIX**

**None.**